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Hydrology of the Metamorphic and Igneous Rocks of Central Chester County, Pennsylvania

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Hydrology of the Metamorphic and Igneous Rocks of Central Chester County, Pennsylvania

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U. S. Geological Survey

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PREFACE

The information in this report on subsurface water resources of central Chester County will benefit all water consumers in that rapidly developing suburban area of southeastern Pennsylvania. With a population increase in the area of about 23 percent from 1950 to 1960 plus rapid growth of commercial and industrial establishments, the great demand for water has necessitated the development of subsurface water resources. Individual and community water wells, as well as industrial wells, are supplying many of the newer establishments with water.

The water-yielding capacities of the rocks in this area differ widely from place to place; yields of more than 300 gallons per minute were obtained from favorably located and properly constructed wells. The ground water occurs in fractures and minute openings in the various rock types. Based on data collected from about 600 wells, the best yields were obtained from wells in valleys, while the poorest yields came from wells on hills or uplands. The water is soft and generally of good quality, except for a minor number of improperly located wells which show evidence of contamination by cesspool or barnyard wastes.

The information in this report should assist planners and water authorities to coordinate water wells with available water resources. Water well drillers will benefit through guidance toward maximum water well yields; the data in this report will help them to know the most favorable locations to drill, probable depths, probable yields, and the anticipated quality of the water.

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Hydrology of the Metamorphic Rocks of Central Chester County, Pennsylvania

by

Charles W. Poth

ABSTRACT

The area covered by this report is in southeastern Pennsylvania and includes not only central Chester County but a small amount of the adjoining Lancaster and Delaware Counties. The rocks underlying the area were mapped by Bascom and Stose (1932) and are chiefly the Baltimore Gneiss, the Glenarm Series (Setters Formation, Cockeysville Marble, Wissahickon Formation, and Peters Creek Schist), and gabbro. The Chester Valley, which trends northeastward across the northwest part of the area, contains the Chickies Quartzite, Harpers Schist, Antietam Quartzite, Vintage Dolomite, Kinzers Formation, Ledger Dolomite, and Elbrook Limestone of Cambrian age; and the Conestoga Formation of Ordovician age. Small bodies of serpentine and pegmatite are scattered throughout the area, except in the Chester Valley. Several diabase dikes of Triassic age trend generally north or northeastward across the area.

The ground water occurs in and moves through these rocks in fractures. The size, number, and degree of interconnection of the fractures intercepted by a well determine the well's sustained yield. Most of the formations were found to yield water to wells through several zones. The zones were generally less than 200 feet below the surface, but some in the Baltimore Gneiss were encountered at depths exceeding 300 feet.

About 10 percent of the wells on which yield data were obtained yielded more than 50 gpm (gallons per minute), and 5 percent of this group yielded more than 330 gpm. The median depth of the wells yielding over 50 gpm was 160 feet and about two-thirds of these wells were situated in draws and valleys.

Depth of weathering does not exert much control on well yields; however, the weathered zone is important as a storage reservoir where it is not highly clayey.

Topography is probably the greatest single factor affecting the yield and depth of wells. Wells in the lower topographic positions yielded more water and were shallower than those on slopes or upland areas.

Increasing metamorphic rank (from slate to gneiss) in some of the Glenarm formations was associated with a decrease in the yield of the wells. It was also associated with an increase in the depth of weathering of the rocks, as shown by the increase in the amount of casing needed in the wells.

The hydrologic properties of the formations were observed to range widely even within short distances. The range was sufficiently great that the formations could not be separated from one another on the basis of their hydrologic properties.

Most of the water was of the calcium-magnesium bicarbonate type. The dissolved-solids content was generally low, median 146 ppm (parts per million), the water was soft, hardness 3 gpg (grains per gallon); and slightly acidic, median pH 6.6.

A large number of the samples analyzed appeared to be contaminated, as indicated by the abundance of nitrate, sulfate, chloride, and sodium. The sources of contamination are believed to be local.

Large yields were obtained from wells in several of the formations. The maximum yields obtained were 270 gpm from the Baltimore Gneiss, 330 gpm from the Cockeysville Marble, 350 gpm from the Wissahickon Formation, 312 gpm from the Peters Creek Schist, 665 gpm from the Vintage Dolomite, 150 gpm from the Ledger Dolomite and Elbrook Limestone, 175 gpm from the Conestoga Limestone, 125 gpm from the gabbro, and 80 gpm from the serpentine.

INTRODUCTION

PURPOSE AND SCOPE

The investigation on which this report is based was undertaken to study the occurrence of ground water in an area of metamorphic and igneous rocks; accordingly, an area was selected that included a large number of these rock types. Some of the principal objectives were to determine the relation of factors such as well yield, well depth, depth of water-bearing zones, depth of weathering, and chemical quality of the water to rock type and topographic and geographic position of the well.

The study was made in an area undergoing rapid suburban development so as to provide information that will aid in the efficient utilization of the ground-water resources.

LOCATION OF THE AREA

The area is in southeastern Pennsylvania between 39° 52′ 30″ and 40° 00′ N. latitude and 75° 30′ and 76° 00′ W. longitude. The West Chester, Unionville, Coatesville, and Parkesburg 7½-minute topographic quadrangles provide topographic coverage for the area. Most of the area is in central Chester County, but the southeast corner of the West Chester quadrangle lies in Delaware County, and a narrow strip along the western border of the Parkesburg quadrangle is in Lancaster County. (Figure 1.)

METHODS OF STUDY

An inventory was made of approximately 620 domestic, industrial, and municipal wells, and 1-hour pumping tests were made on 94 of these wells. Electric logs were made of five wells and the depth and yield of water-bearing zones were determined by the brine-tracing method on the same wells. Periodic water-level measurements were made on three wells. Approximately 400 samples of ground water were tested in the field for pH, hardness, and specific conductance. More complete chemical analyses of 31 samples were made in the laboratory of the U. S. Geological Survey.

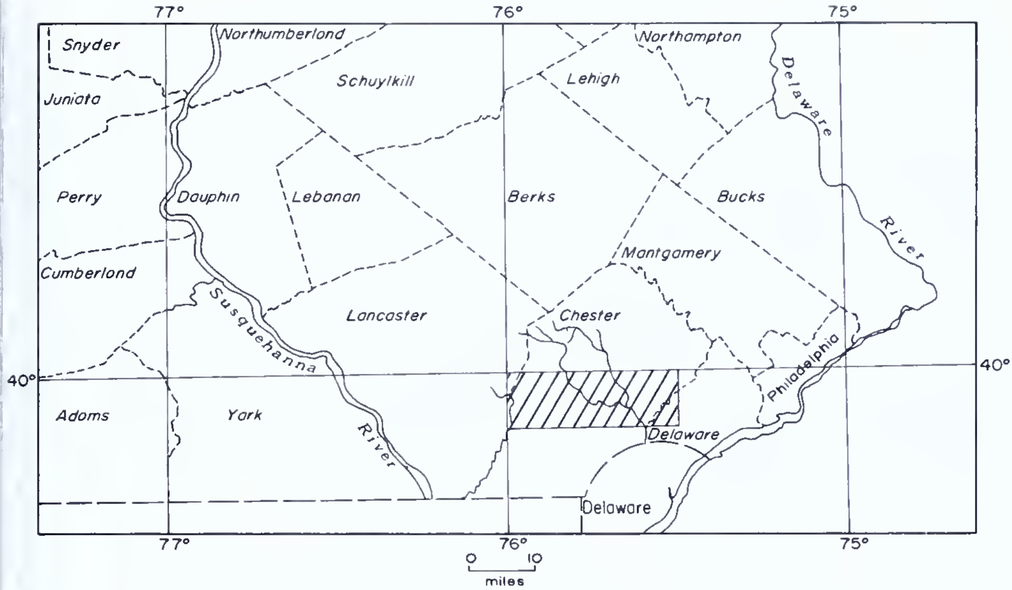


Figure 1. Map of southeastern Pennsylvania showing the location of the area of this investigation.

PREVIOUS INVESTIGATIONS

Southeastern Pennsylvania is one of the classic problem areas of North American geology and has been thought to hold the key to the solution of problems in both the northern and southern Appalachians. As such, it has been the focus of much study, and many reports have been written about the geology of the area. For the purpose of this report, however, it is sufficient to mention only a few.

The geology was mapped by Bascom and Stose (1932) and structural details of part of the area were further delineated by McKinstry (1961). Swartz (1948) offers an excellent summary of work done up to 1948.

The ground-water resources were discussed briefly by Hall (1934) in a report on the ground water in southeastern Pennsylvania. Olmsted and Hely (1962) described ground-water surface-water relationships in the Brandywine basin.

ACKNOWLEDGMENTS

The writer is grateful to the many well owners who allowed their wells to be test pumped or sampled, and to the following drillers who kindly provided information: Artesian Well Drilling Co., Brookover Well Drilling Co., Thomas G. Keyes, Charles Lauman, Clifford Myers, Lee Myers, I. N. Petersheim and Son, R. Walter Slaugh and Sons, and Hope Womble.

W. C. Roth assisted the writer on some of the pumping tests and conducted the geophysical investigations.

WELL-NUMBERING SYSTEM

The well-numbering system used in this report shows the location of wells according to a latitude-longitude grid system. Each number consists of three groups of digits. For example, in the number 959-532-3, which was assigned to a well at Goshenville in the West Chester quadrangle, the first group (959) is composed of the last digit of the degrees (39) and the two digits of the minutes (59) that define the latitude on the south side of a 1-minute quadrangle; the second group (532) consists of the last digit of the degrees (75) and the two digits of the minutes (32) that define the longitude on the east side of a 1-minute quadrangle. The last segment (3) indicates the consecutive number assigned to the well in this 1-minute grid. Plates 1 and 2 show the locations of selected wells in the project area.

GEOGRAPHY

Topography and Drainage

The area of the investigation is in the Piedmont Province and lies mostly in the Piedmont Upland Section, but it includes also the Chester Valley —a narrow, elongate extension of the Conestoga Valley Section—which trends northeastward across the Parkesburg and Coatesville quadrangles and intercepts the northwest corner of the Unionville quadrangle.

The upland is maturely dissected and slopes gently southeastward. The highest hill is in the northwest corner of the Parkesburg quadrangle; it reaches an altitude of 860 feet. The lowest altitude is in the southwest corner of the West Chester quadrangle, where the Brandywine Creek leaves the area at an altitude of about 160 feet.

About two-thirds of the area is drained by the Brandywine Creek, which flows into the Delaware River via Christiana River. The drainage divides of the Brandywine are located approximately by north-south lines through Parkesburg and West Chester. The area west of the Brandywine basin is drained into the Susquehanna River by Octoraro Creek and its tributaries. East of the Brandywine basin the area is drained by Chester and Ridley Creeks, which flow into the Delaware River.

Climate

The climate of southeastern Pennsylvania is characterized by hot, humid summers during which temperatures reach 90° F or above on an average of 25 days each year. Winters are comparatively mild, for temperatures rarely reach 0° F and fall below freezing on an average of less than 100 days each year. Approximately 30 inches of snow falls each year, and the land is snow-covered about one-third of each winter. The frost-free period averages about 180 days.

Climatic data are available from two stations of the U. S. Weather Bureau in the area. One set of data is recorded at the Philadelphia Electric Co., 1 mile southwest of Coatesville; the other is recorded at the Daily Local News, at West Chester. These data (based on a period of record from 1931-1955) show that the area has a mean annual temperature of about 53° F and a mean annual precipitation of about 46 inches. Monthly averages of temperature and precipitation for each station are shown in the following table.

Average monthly temperature and precipitation at U. S. Weather Bureau stations for the period 1931-1955[1]

Month	Temperature (°F)		Precipitation (inches)	
	Coatesville	West Chester	Coatesville	West Chester
January	30.5	30.8	3.87	3.76
February	30.6	31.4	3.62	3.63
March	39.9	39.4	4.13	3.92
April	50.4	50.0	3.73	3.69
May	61.4	61.0	3.90	4.34
June	70.3	69.7	4.21	4.26
July	75.2	75.5	4.19	4.55
August	72.9	73.3	5.29	5.37
September	65.8	66.9	3.15	3.54
October	54.9	56.5	3.17	3.14
November	43.2	45.1	3.60	3.96
December	33.0	34.8	3.33	3.28

[1] Kaufman, N. M., 1960.

Population and Water Use

The population of the area has increased about 23 percent (to nearly 73,500) between 1950 and 1960; a rate of growth that is nearly three times that of the state as a whole (7.82 percent). Most of the increase has taken place around West Chester, in townships such as Pocopson, Thornbury, West Goshen, Westtown, and Willistown, where the population has more than doubled.

The growth rate of the boroughs has been much less than the townships. The City of Coatesville, for example, lost about 6 percent of its population between 1950 and 1960. The townships adjacent to each of the municipalities show an attendant increase in population that more than balances the latter's growth rate.

The changes in population are producing a change in the pattern of water use. The large municipalities such as West Chester and Coatesville have utilized surface-water supplies and are continuing to do so. However, the increasing demand for water in the townships is being satisfied by ground water. Individual wells are used at isolated houses and in some of the housing developments, but community wells are used for public supply in an increasing number of the new developments.

GEOHYDROLOGY

GEOLOGIC SETTING

The geology of southeastern Pennsylvania is extremely complex and has been the subject of much study. Swartz (1948) offers an excellent summary. More recently McKinstry (1961) has published the results of a detailed study of the structure of the controversial Glenarm Series, which underlies a large part of the area.

Geologic Structures

The rocks in the area covered by this report range in age from Precambrian to Ordovician, and are chiefly metamorphosed sediments, but they include also considerable amounts of igneous rocks. Because of their age and position in the Appalachian geosyncline, the rocks have been intensively folded and faulted. The prominent structures of the area are shown in Figure 2.

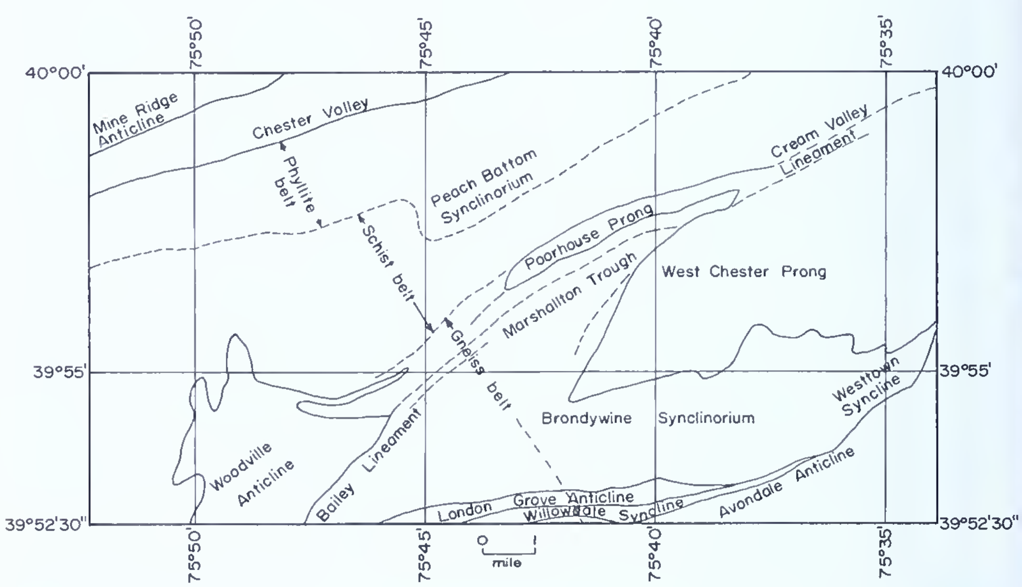


Figure 2. Map showing the major geologic structures and zones of metamorphism (modified from McKinstry, 1961).

The Chester Valley, a narrow, elongate feature on the northwest limb of a syncline in the Peach Bottom synclinorium, trends east-northeast across the western part of the area. The valley is underlain by Cambrian and Ordovician limestone and dolomite and is flanked along the northern side by Cambrian quartzite and schist. The hills north of the valley are on the southeast limb of the Mine Ridge anticline; they are underlain by Precambrian gneiss and gabbro containing small elongate intrusions of

serpentine, and by fault-slices of Cambrian quartzite, schist, and carbonates. Dikes and sills of pegmatite strike predominantly east-northeastward across the gneiss, the gabbro, and the quartzite.

South and east of Chester Valley the area is underlain chiefly by gabbro-intruded gneiss and a group of metamorphosed sediments known as the Glenarm Series. Several prominent diabase dikes of Triassic age strike northeastward across the area.

The southwestward-plunging anticlinal West Chester Prong and the Brandywine synclinorium are the dominant structural features in the central part of the area. The northeast end of the Brandywine synclinorium extends along the northwest flank of the West Chester Prong, where it is termed the Marshallton Trough and is, in turn, flanked by the narrow anticlinal Poorhouse Prong. The synclinorium extends along the southeast side of the West Chester Prong also—where its eastern end is called the Westtown syncline.

The recumbent Woodville anticline, which has been overturned to the northwest, lies at the nose of the Brandywine synclinorium. The London Grove anticline, which appears to merge eastward into the northeast-trending Avondale anticline, lies along the south side of the synclinorium.

The synclines are in areas of phyllite or schist. In the anticlines, however, a gneissic core is exposed, and frequently this core has been intruded by gabbro. The flanks of the anticlines may expose schist or marble.

Geologic Formations

The formations, and their thickness and generalized character are summarized in Table 1. More details are given in the section on the stratigraphy and water-bearing properties of the rocks.

GROUND-WATER PRINCIPLES

Source

Ground water is precipitation which has percolated downward through the soil and openings in the rocks to a zone within which all interconnected openings are filled with water under pressure greater than atmospheric. The upper surface of this zone is called the water table. Ground water moves continuously from points of high hydraulic head to points of lower hydraulic head and eventually to points of discharge—perhaps into another formation, to a spring, a stream, or to a well.

Fluctuations of Ground-Water Levels

If water is added to the ground-water reservoir (aquifer) at a faster rate than it can be discharged, the water level will rise in the aquifer.

TABLE 1.—*Generalized geologic section (modified after Bascom and Stose)*

System	Series	Formation	Thickness (feet)	Character
Triassic		Diabase	?	Medium- to fine-grained rocks; composed chiefly of plagioclase and pyroxene. Present as dikes.
Ordovician	Lower Ordovician	Conestoga Limestone	500+	Thin-bedded blue to gray granular limestone; has thin dark shale and impure limestone partings; limestone in part conglomeratic at base.
	Middle Cambrian	Elbrook Limestone	300+	Finely laminated, fine-grained impure marble; weathers shaly.
		Ledger Dolomite	600	Granular, crystalline light-gray to white dolomite.
		Kinzers Formation	150	Micaceous limestone and calcareous mica schist.
Cambrian	Lower Cambrian	Vintage Dolomite	300+	Massive, knotty, granular, glistening, dark-gray dolomite.
		Antietam Quartzite	150	Gray laminated quartzite, rust spotted, and contains fossil molds.
		Harpers Schist	280—1,000+	Gray sandy micaceous schist; has thin quartzite beds.
		Chickies Quartzite and Hellam Conglomerate Member	500	Vitreous to granular quartzite, massive and thin bedded, some quartz schist and mica schist; conglomerate-bearing beds at base.

TABLE 1.—*Generalized geologic section (modified after Bascom and Stose)—Continued*

System	Series	Formation	Thickness (feet)	Character
Age uncertain—Precambrian to Lower Paleozoic		Gabbro	?	Chiefly calcic plagioclase and hypersthene or augite; may contain quartz. In small masses hornblende replaces pyroxenes.
Age uncertain—Precambrian to Lower Paleozoic		Pegmatite	?	Ranges in composition from that of granite to gabbro. Present as small sill-like bodies.
Age uncertain—Precambrian to Lower Paleozoic		Serpentine	?	Altered peridotite and pyroxenite. Present in small isolated exposures.
Age uncertain—Precambrian to Lower Paleozoic	Glenarm	Peters Creek Schist	2,000+	Green fine-grained laminated chlorite mica schist.
		Wissahickon Formation	5,000—8,000+	Chlorite phyllite and muscovite schist, injected by gabbro.
		Cockeysville Marble	200+	Medium to coarse grained white saccharoidal marble, banded with phlogopite.
		Setters Formation	1,000+	Quartz schist, quartzite, and mica gneiss.
Precambrian		Baltimore Gneiss and Franklin Limestone	?	Contorted, banded gneiss, in part graphitic, injected by gabbro, and serpentine. Franklin Limestone is a banded, white, coarsely crystalline marble containing graphite.

The amount of recharge an aquifer receives depends upon the amount and distribution of precipitation. Most recharge occurs during the winter and spring months.

Despite the fact that approximately 13 percent more precipitation falls between April and September than between October and March, little recharge occurs during the summer and fall months, because higher temperatures plus the growth of plants result in the evapotranspiration or consumption of nearly all precipitation. By the middle of May, generally, water levels begin to decline and may continue to do so past the period of high temperatures and the growing season. Cool and unusually wet summers and falls may allow recharge to occur a few weeks earlier than usual and may hold water levels slightly above their normal annual lows, but generally little recharge occurs during this period and that which does occur produces only a small and temporary reversal of the downward trend of the water level.

The rate at which the water level falls and the size of the annual fluctuation depend chiefly on the permeability of the rocks, the height of the water above points of discharge, and the distance the water must travel to the discharge point.

Plate 3 shows the water-level fluctuations in well 956-555-1 in Chester County.

Occurrence

In unconsolidated rocks such as sands and gravels the water occurs in and moves through the interstices between the grains (called primary openings). In consolildated clastic rocks such as sandstones and shales, and in crystalline rocks such as limestones, gneisses, schists, and gabbros that underlie the area covered by this report, the water is confined mainly to fractures (secondary openings).

Pumping Effects

In a well supplied from primary openings, water generally enters the borehole throughout the entire saturated thickness of the aquifer. In a well supplied by secondary openings, water generally enters the borehole in discrete zones separated from each other by nonproductive zones.

The amount of water a well is capable of yielding depends on the size, number, and degree of interconnection of the water-filled openings intercepted by the well. It depends also on how these features change at different distances from the well. As the well is pumped, the water level is drawn down in the well and in the formation surrounding the well. The zone in which the water level is drawn down is called the cone of depression. As pumping continues, the cone deepens and grows in areal extent as water from an ever greater area is diverted from its natural flow path to replace the water pumped from the well. If the aquifer is

homogeneous and isotropic, the cone will be circular and will expand at a uniform rate; if it is not, and this is common where water occurs in fractures in the rock, the cone will not be circular, and it will expand erratically. The effect can be noted at the well (Figure 3) by observing the rate of drawdown of the water level in the well. If the producing fractures enlarge or intersect larger or more numerous water-yielding fractures near the well, the rate of drawdown of the water level in the well will decrease markedly as the cone reaches outward. If the producing fractures decrease in size or if some of them terminate, the rate of drawndown will increase markedly to reflect the reduction in permeability.

The water level in a well is drawn down rapidly when pumping begins, but the rate of drawdown decreases as pumping continues and the cone expands. The rate at which water is supplied to the well depends on the permeability of the aquifer and the hydraulic gradient in the aquifer. In a well supplied from a single yielding zone, the maximum effective gradient is obtained when the water level stands at the base of the yielding zone. As pumping continues, and water is drawn from more distant parts of the aquifer, the gradient (and hence the yield of the zone) will gradually decline. The water level in the well will decline rapidly as it falls below the base of the zone and water is taken from storage in the borehole.

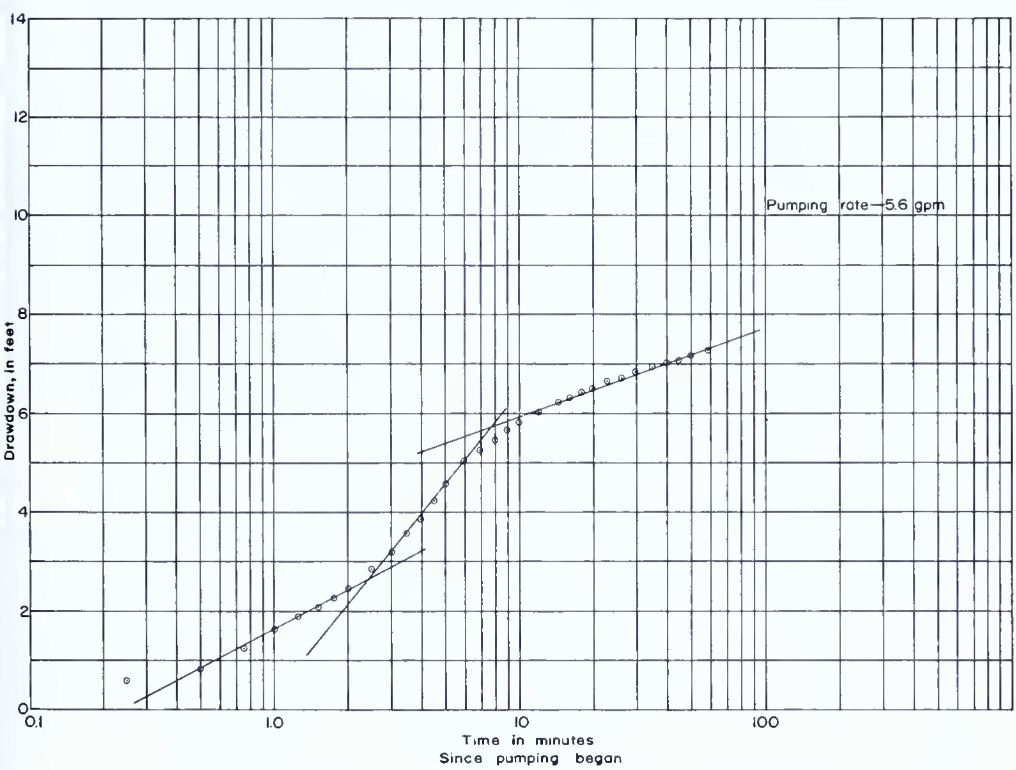


Figure 3. Graph showing drawdown of the water level in well 956-536-2 during pumping.

Well Yields

The capacity of a well is generally reported in either of two ways: (1) as yield, in gallons per minute (gpm) or (2) as specific capacity, in gallons per minute per foot of drawdown (gpm per ft.). The former is commonly obtained at the time the well is drilled by measuring the rate at which water must be removed from the well by bailing (if a churn drill is used) or blowing (if a pneumatic rotary drill is used) to maintain the water level near the bottom of the well. The method is properly applied only to wells whose yields are small enough to allow the water in the borehole to be removed in this way.

Where larger capacities are to be estimated a pump is generally used. In this method, the water level is pumped down nearly to the bottom of the well and the pump is then throttled back to the point at which the water level in the well stabilizes. This discharge is taken as the yield of the well.

The critical part of the yield test is the thoroughness with which the water is removed from the borehole. If the drawdown is less than the maximum, then the reported yield will be some fraction of the well's potential yield.

The specific capacity test requires only that the well be pumped at a constant rate and that accurate measurements be made of the drawdown and discharge. The specific capacity thus obtained may be used to predict the behavior of the well at higher pumping rates as long as the water level in the well is not drawn down below the place at which the water enters the well, as discussed under pumping effects.

The results of neither the yield test nor the specific capacity test in fractured rock can be extrapolated safely to a time greater than the length of the test because of the possibility that the expanding cone of depression will encounter erratic changes in permeability. However there will be a tendency for the yield of the well to decrease slowly during continuous pumping owing to increasing frictional losses in head as water is drawn from greater distances to the well.

In addition to the factors discussed above, the specific capacity may decrease as the discharge increases owing to several factors that may be grouped conveniently as well losses. Because these factors may be minimized by proper well design and construction they are here described individually.

A major part of the well loss is due to friction as the water passes through the well face into the borehole. This friction is caused by imperfect development of the well or by clogging of the well by clays, iron compounds, and other encrustations that reduce the size of the openings through which the water must pass. By surging the well with solutions designed to remove the encrusting materials, the materials may be removed and the well yield improved.

At any given discharge, the velocity at which the water enters the well

is inversely proportional to the diameter of the well. High entrance velocities may cause considerable loss in head because of internal friction due to turbulence. Thus, by increasing the diameter of the well, the entrance velocity may be reduced and part of the well losses minimized.

Turbulence may be produced in the well itself if the annular space between the pump and the walls of the well is too small for the velocity at which the water is moving. This, too, may be minimized by enlarging the well.

In this study, specific-capacity tests were standardized at 1 hour's duration, although for many uses a longer test would have been advantageous. However, by standardizing the length of the tests it was possible to compare results of tests in different aquifers and in different environments. Such comparisons permit selection of the most favorable sites for drilling when a ground-water supply is required.

Although inherently less accurate and less flexible than specific capacities, well yields are also used in this report because they do offer some estimate of a well's capacity, are abundant, and furnish information that would not be available otherwise on some aquifers and in some areas. The relationship of yield to specific capacity in the area of the investigation is shown in Figure 4.

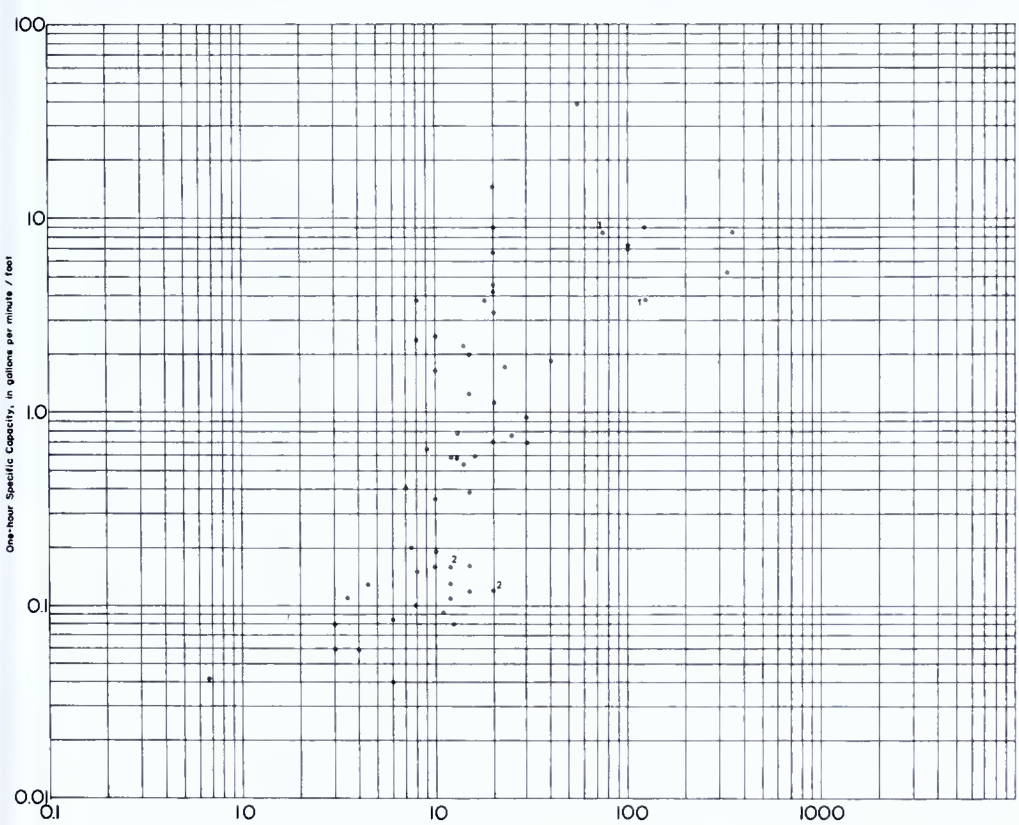


Figure 4. Graph showing the relation of reported well yields in gpm to 1-hour specific-capacity tests. Number next to point indicates the number of sets of data having this value.

Evaluation of Well Data

In most instances well yields are not necessarily representative of the yields that could be obtained because the bulk of the wells have been drilled to supply domestic needs (5-10 gpm). Because of their intended use, they were probably located for convenience rather than at the most favorable site, and were drilled only to a depth sufficient to supply domestic needs. A large-yielding domestic well, then, is one that intercepted a large supply at shallow depths. What the yield would have been had the well been drilled deeper is not known. A deep domestic well, furthermore, is generally one that could not obtain a domestic supply at shallow depth, and is probably in an unfavorable place for a well.

Thirty-six wells, or approximately 10 percent of the wells for which yields were reported or measured, yield over 50 gpm. These include wells drilled for municipal supply, for eommunity supply in housing developments, at industrial plants, at mushroom farms, and at a few private homes. The median yield of the 36 wells was 100 gpm, and the median yield of all reported yields was 15 gpm. Five percent of the high-yielding wells yielded over 330 gpm, whereas only 5 percent of wells inventoried yielded more than 88 gpm.

It is instructive to compare the parameters of the 36 high-yielding wells with those of all the wells inventoried. The median depth of the better wells is 160 feet—or about 60 feet more than that of the group as a whole. About 10 percent of the high-yielding wells exceeded 300 feet in depth, whereas only about 3 percent of all the wells were deeper than 300 feet.

Unfortunately, information on the number and depth of water-bearing zones was not available on many of the wells, especially the high-yielding ones. However, based on the data available, about 10 percent (4 out of 41) of the water-bearing zones of the high-yielding wells were below 170 feet, whereas only about 4.5 percent of the zones of the entire group were deeper than 170 feet.

The most striking difference between the high-yielding wells and the rest of the wells was in their topographic positions. Two-thirds of the high-yielding wells were in draws or valleys, whereas only one-third of all the wells inventoried were in draws or valleys.

Despite the fact that most of the wells were neither deep enough to realize maximum yields nor favorably situated for such yields, an inventory of the wells was necessary because there were not enough municipal or industrial wells to provide an understanding of the factors controlling the occurrence of ground water in the area. If it is assumed that the basis for the location of domestic wells is the same throughout the area, it is possible to use the data from these wells to evaluate the influence of such factors as geologic formation, topographic position, and degree of metamorphism of the rocks.

Aquifer Hydrology

Table 2 summarizes the important parameters of the wells, except those concerned with yielding zones. The Baltimore Gneiss, the gabbro, the Wissahickon Formation, and the Peters Creek Schist (the most extensive rocks in the area) are both the most important and the best understood of the aquifers. A few of the rock units were so small in areal extent that hydrologic data on them were not available; they include the Franklin Limestone, the Antietam Quartzite, and the pegmatite.

The range of the data is given in the table rather than percentiles, because data are abundant enough to merit the use of percentiles in only a few aquifers. Percentiles are presented, however, in the discussion of those few aquifers.

Table 3 summarizes data available on water-bearing zones. The table is in two parts. Table 3-A contains a variety of information.

First, as the denominator of the fraction indicates the number of wells penetrating any particular depth range, the denominator of the shallowest range obviously indicates the total number of wells in that formation for which data on depth to water-bearing zones were obtained. Thus, data were obtained from 40 wells in the muscovite phase of the Wissahickon Formation.

Second, the table indicates the maximum depth range of the wells for which yielding-zone data were obtained. In the "normal" phase of the Baltimore Gneiss, for example, 4 wells exceeded 200 feet in depth and 2 were between 301 and 350 feet deep. No yielding zones were encountered in any of the 4 wells 201 to 300 feet deep, but 2 zones were encountered between depths of 301 and 350 feet.

Third, the relative abundance of zones at different depths is shown by the value of the fraction. In the gabbro, for instance, the relative abundance of zones is seen to decrease as the depth increases. The comparison of abundances, however, does become less sensitive as the depth increases because of the decreasing size of the sample. Thus, the data give some suggestion of the practical depth to which a well should be drilled in a formation in order to obtain maximum production. In the chlorite phase of the Wissahickon, only one zone was found below 150 feet in the 7 wells that exceeded this depth.

Available data do not always fully explore the depth of the yielding zones in some formations (such as the Setters); so, drilling to depths greater than those of existing wells may be recommended.

Table 3-B may be used to estimate the number of yielding zones a well in a particular formation may be expected to intercept and to indicate qualitatively the performance of the well under pumping conditions. As discussed in an earlier section, the specific capacity of a well will decrease as the water level is drawn down below a yielding zone; so, a well that yields principally from a single zone, such as most of the wells in the

TABLE 2.—*Summary of well data*

Formation	Reported yield			Specific capacity			Well depth			Casing depth		
	Number of Wells	Range (gpm)	Median (gpm)	Number of Wells	Range (gpm per ft)	Median (gpm per ft)	Number of Wells	Range (feet)	Median (feet)	Number of Wells	Range (feet)	Median (feet)
Baltimore Gneiss												
"Normal" phase	64	1-270	17	10	0.2-8.9	0.93	89	31-359	84	56	10-76	33
Gabbro-intruded phase	55	¾-125	11	9	.06-9.0	2.2	69	45-265	102	50	14-69	39
Graphitic phase	3	½-45	15	0	......	..	3	50-154	145	2	28-32	30
Setters Formation	5	12-33	16	3	.2-2.5	.6	8	69-140	106	6	17-100	40
Cockeysville Marble	3	3-330	20	4	.1-78.5	3.15	6	33-170	86	4	20-80	42
Wissahickon Formation												
Chlorite phase	41	0-80	8	18	.04-38.2	2.4	63	35-1,000	125	46	15-200	15
Muscovite phase	77	0-350	10.5	20	.06-8.4	.4	115	48-400	112	67	10-157	40
Peters Creek Schist	35	0-312	11.3	18	.03-11.3	1.0	69	32-426	92	36	6-110	29
Chickies Quartzite	6	2-20	12	2	.2	.2	11	42-222	112	9	13-60	22
Hellam Conglomerate Member	0	......	....	1	......	.05	8	38-170	68	1	......	74
Harpers Schist	6	4-30	14	1	......	1.7	7	28-160	125	5	28-120	36

TABLE 2.—*Summary of well data—Continued*

Formation	Reported yield			Specific capacity			Well depth			Casing depth		
	Number of Wells	Range (gpm)	Median (gpm)	Number of Wells	Range (gpm per ft)	Median (gpm per ft)	Number of Wells	Range (feet)	Median (feet)	Number of Wells	Range (feet)	Median (feet)
Antietam Quartzite	0	......	....	0	......	..	0	....	....	0	......	..
Vintage Dolomite	2	3-665	334	0	......	..	2	55-300	178	1	......	208
Kinzers Formation	0	......	....	0	......	..	2	65-147	106	1	......	4
Ledger Dolomite	5	7-150	25	0	......	..	7	42-400	118	4	5-100	40
Elbrook Limestone	2	15-150	82	0	......	..	2	85-200	142	2	50-100	75
Conestoga Limestone	9	7-175	20	2	.1- .4	.3	16	42-200	90	8	18-134	49
Gabbro	45	½-125	10	5	.2- 3.9	1.3	52	36-235	94	39	10-87	33
Serpentine	4	4-80	18	1	......	.6	5	40-310	104	2	15-108	62
Pegmatite	0	......	..	0	......	..	1	....	100	0	......	..
Diabase	1	......	½	0	......	..	1	....	255	1	......	23

TABLE 3.—*Summary of data on water-bearing zones*

Formation	Table 3-A.—Ratio of number of water-bearing zones of specified depth range to number of wells penetrating this range — Depth range, in feet								Table 3-B.—Percentage distribution of zones in wells. — Zones per well						
	0-50	51-100	101-150	151-200	201-250	251-300	301-350	351-400	1	2	3	4	5	6	7
Baltimore Gneiss															
"Normal" phase	38/44	35/41	4/15	5/9	0/4	0/2	2/2		39	36	20	5			
Gabbro-intruded phase	27/33	33/32	2/13	1/5	0/1				43	27	27	3			
Graphitic phase	0/2	1/2	1/2						0	100					
Setters Formation	2/4	3/4	2/4						75	0	0	25			
Cockeysville Marble	0/1	0/1	1/1						100						
Wissahickon Formation															
Chlorite phase	12/20	13/20	8/16	1/7	0/3	0/3	0/2	0/2	55	25	15	5			
Muscovite phase	27/40	36/40	16/25	8/13	3/9	2/3	0/1	0/1	27.5	45	15	5	2.5	2.5	2.5

TABLE 3.—*Summary of data on water-bearing zones—Continued*

Formation	Table 3-A.—Ratio of number of water-bearing zones of specified depth range to number of wells penetrating this range								Table 3-B.—Percentage distribution of zones in wells.						
	Depth range, in feet								Zones per well						
	0-50	51-100	101-150	151-200	201-250	251-300	301-350	351-400	1	2	3	4	5	6	7
Peters Creek Schist	6/12	10/11	1/6	0/4	2/2	0/1	0/1		59	33	0	8			
Chickies Quartzite	4/4	1/3	0/1	1/1	1/1				25	75					
Hellam Conglomerate Member	?/0								—						
Harpers Schist	0/3	6/3	2/3						33.3	33.3	33.3				
Antietam Quartzite	?/0								—						
Vintage Dolomite	?/0								—						
Kinzers Formation	1/2	0/2	1/1						100						

TABLE 3.—*Summary of data on water-bearing zones—Continued*

Formation	Table 3-A.—Ratio of number of water-bearing zones of specified depth range to number of wells penetrating this range								Table 3-B.—Percentage distribution of zones in wells.						
	Depth range, in feet								Zones per well						
	0-50	51-100	101-150	151-200	201-250	251-300	301-350	351-400	1	2	3	4	5	6	7
Ledger Dolomite	2/5	1/5	3/3	0/2	0/2	0/1	0/1	0/1	80	20					
Elbrook Limestone	1/1	1/1							0	100					
Conestoga Limestone	1/3	2/3							100						
Gabbro	35/28	21/27	7/16	3/8	0/5				29	32	21	14	4		
Serpentine	2/2	0/2	1/2	1/1	0/1	0/1	0/1		50	0	50				
Pegmatite	?/0								—						
Diabase	0/1	1/1	0/1	0/1	0/1	0/1			100						

Ledger Dolomite, will suffer a more severe curtailment of yield than will a well in a formation such as Wissahickon, which commonly yields from several zones.

Ideally, Table 3 should show also the capacities of the zones to yield water and how the capacities differ at different depths. Such data were too scarce to put into a table, but they are discussed in connection with the appropriate formation.

EFFECT OF WEATHERING ON HYDROLOGY

In most places, a soft and poorly consolidated zone of weathered rock lies immediately below land surface. This zone is generally incapable of supporting itself and will collapse into the borehole unless kept from doing so by the use of casing. Casing is generally set just a few feet below the base of the zone—into more solid rock. Only rarely, as when caving zones are encountered at considerable depths in a well or when undesirable water must be sealed off, are greater amounts of casing used. Thus, the depth of weathering of the rocks in an area can generally be determined by the amount of casing used in the wells.

The thickness of the weathered mantle is considered important, because the mantle contains the major part of the water stored in the rocks of the area. The fractures that serve as conduits have a low capacity for storage.

The range and median depth of casing in wells are listed in Table 2. In most formations, the median depth is between 20 and 40 feet. Somewhat more casing is needed in wells in carbonate rocks than in other rocks of the area, because clay resulting from the weathering of the rocks may fill the fractures and solution cavities in many places. These cavities must be cased off. In such places, the casing is extended downward from the surface through both the overlying residuum and any fresh rock overlying the clay-filled solution opening.

EFFECT OF TOPOGRAPHY ON HYDROLOGY

The importance of topography to the hydrology of an area has long been known. (See LeGrand, 1949; Mundorff, 1948; and Dingman and Meyer, 1954.) To evaluate its effect in the area covered by this report a simple four-fold classification was used to divide the topography into (1) uplands, (2) slopes, (3) draws or small stream valleys and linear depressions on the slopes, and (4) the valleys of the major through-flowing streams. The last category is less useful than the others because it is dominated by the Chester Valley, which is underlain chiefly by carbonate rocks (so that it is difficult to distinguish the effect of topographic position from that due to rock type), and because there are fewer data in the valley category than in the others.

The most important effect of topography is that well capacity increases as the relative elevation decreases. Figures 5 and 6 show the cumulative percentage distribution of reported yields and specific capacities in each of the topographic classes.

If the effect of topography on the individual formations is considered separately, the relationships are less definitive, as the most favorable topo-

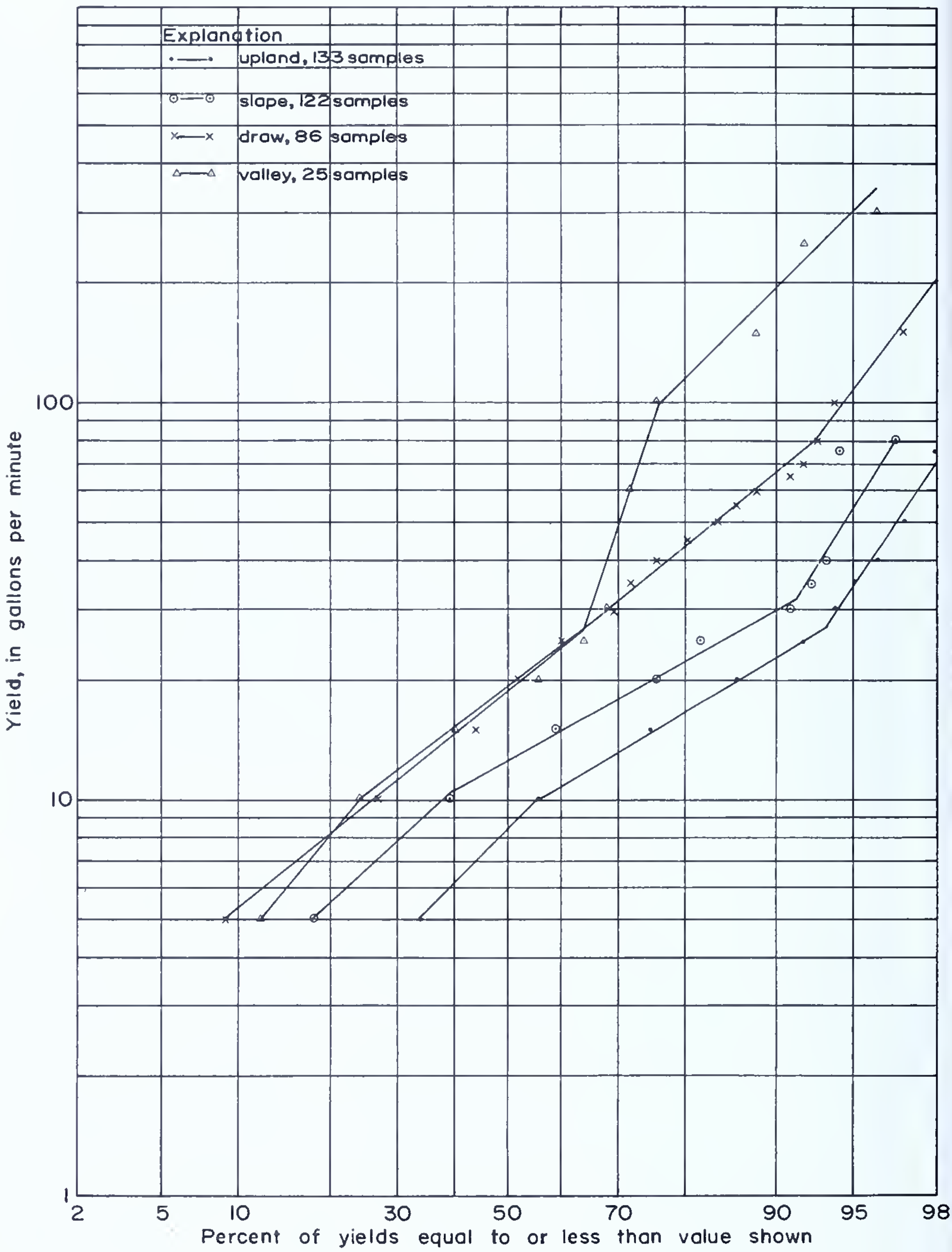


Figure 5. Graph showing the percent frequency distribution of reported well yields, grouped according to topographic position.

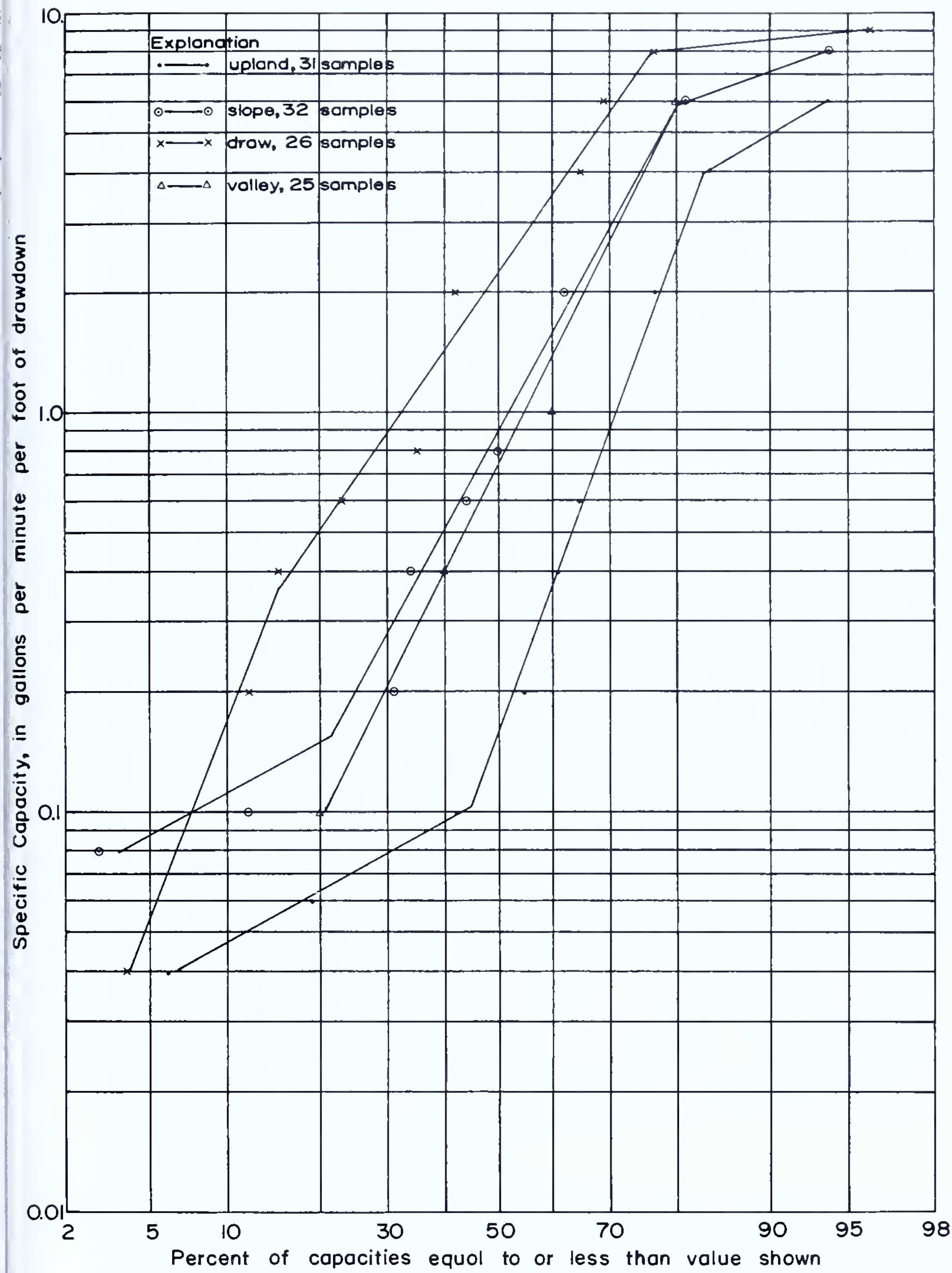


Figure 6. Graph showing the percent frequency distribution of specific capacities, grouped according to topographic position.

graphic position is not the same in all formations. Figure 7, for example, shows that in the gabbro-intruded phase of the Baltimore Gneiss well yields are highest in draws, intermediate on slopes, and poorest on uplands; but in the "normal" phase of the Baltimore, wells in uplands are superior to those on slopes.

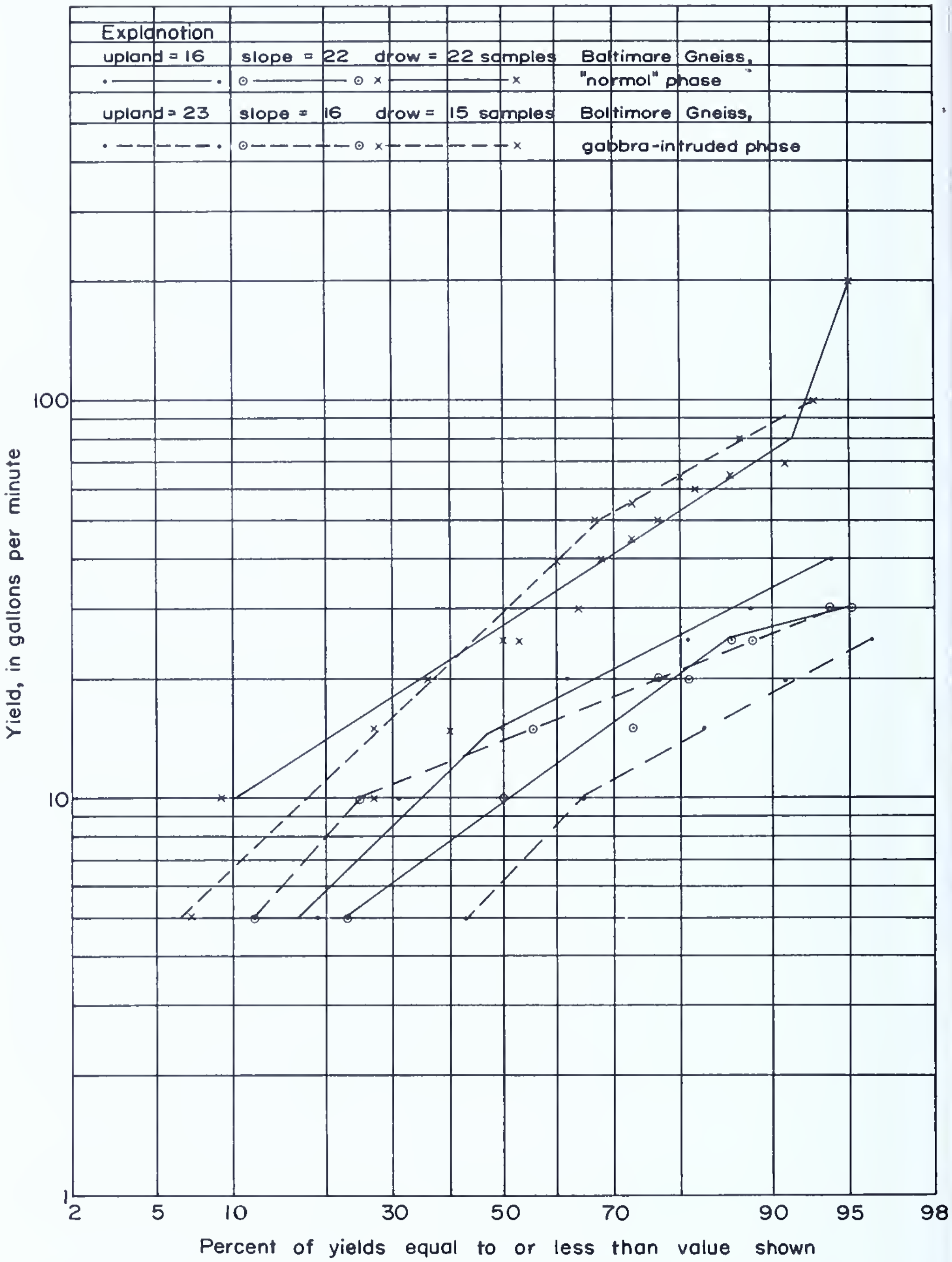
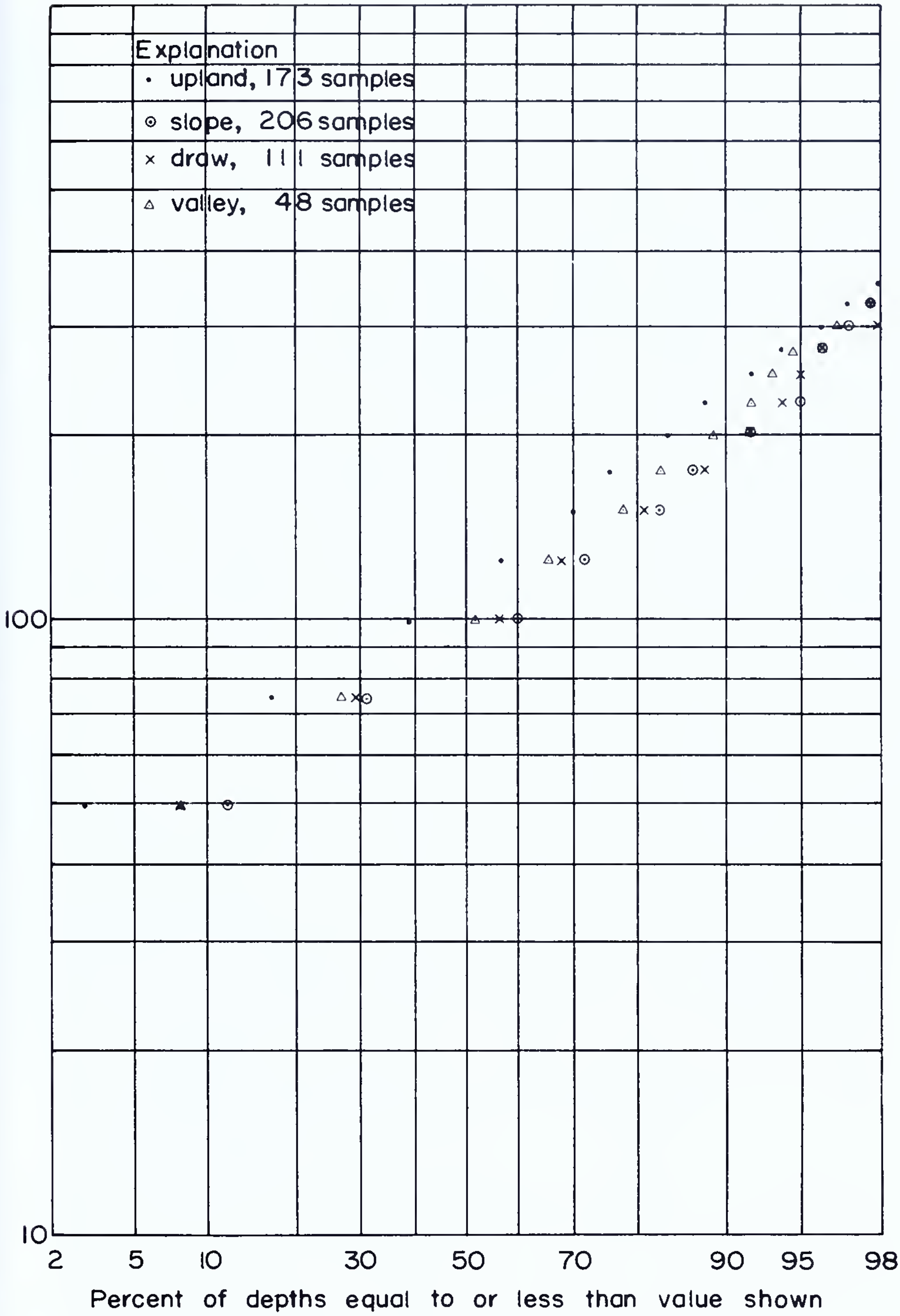


Figure 7. Graph showing the percent frequency distribution of reported well yields in the "normal" and gabbro-intruded phases of the Baltimore Gneiss, grouped according to topographic position.

The distribution of well depths by topography is shown in Figure 8. The range in median well depths among the four topographic positions for the combined formations is 30 feet. In most formations where the data are abundant enough to permit comparisons, the range in well depths is



igure 8. Graph showing the percent frequency distribution of well depths, grouped according to topographic position.

ıbout the same as for the combined formations, although the smallest ange is 17 feet (in the gabbro-intruded phase of the Baltimore) and the argest is 45 feet (in the Peters Creek Schist).

Wells in the uplands are usually the deepest, but the shallowest well are evenly divided between slopes and draws.

The distribution of casing depths (and, hence, the depth of weather ing) in the different topographic positions is shown in Figure 9. Mos

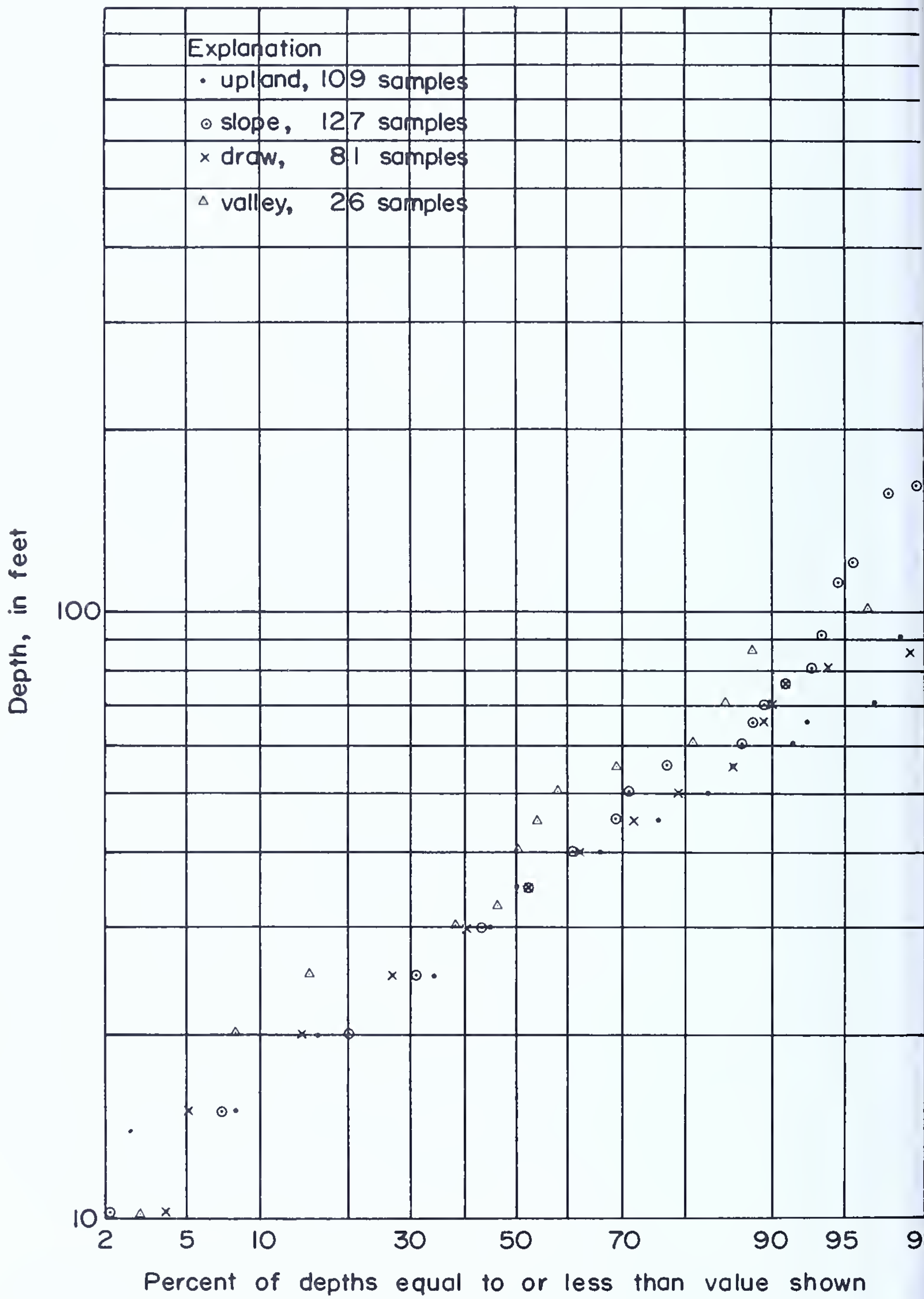
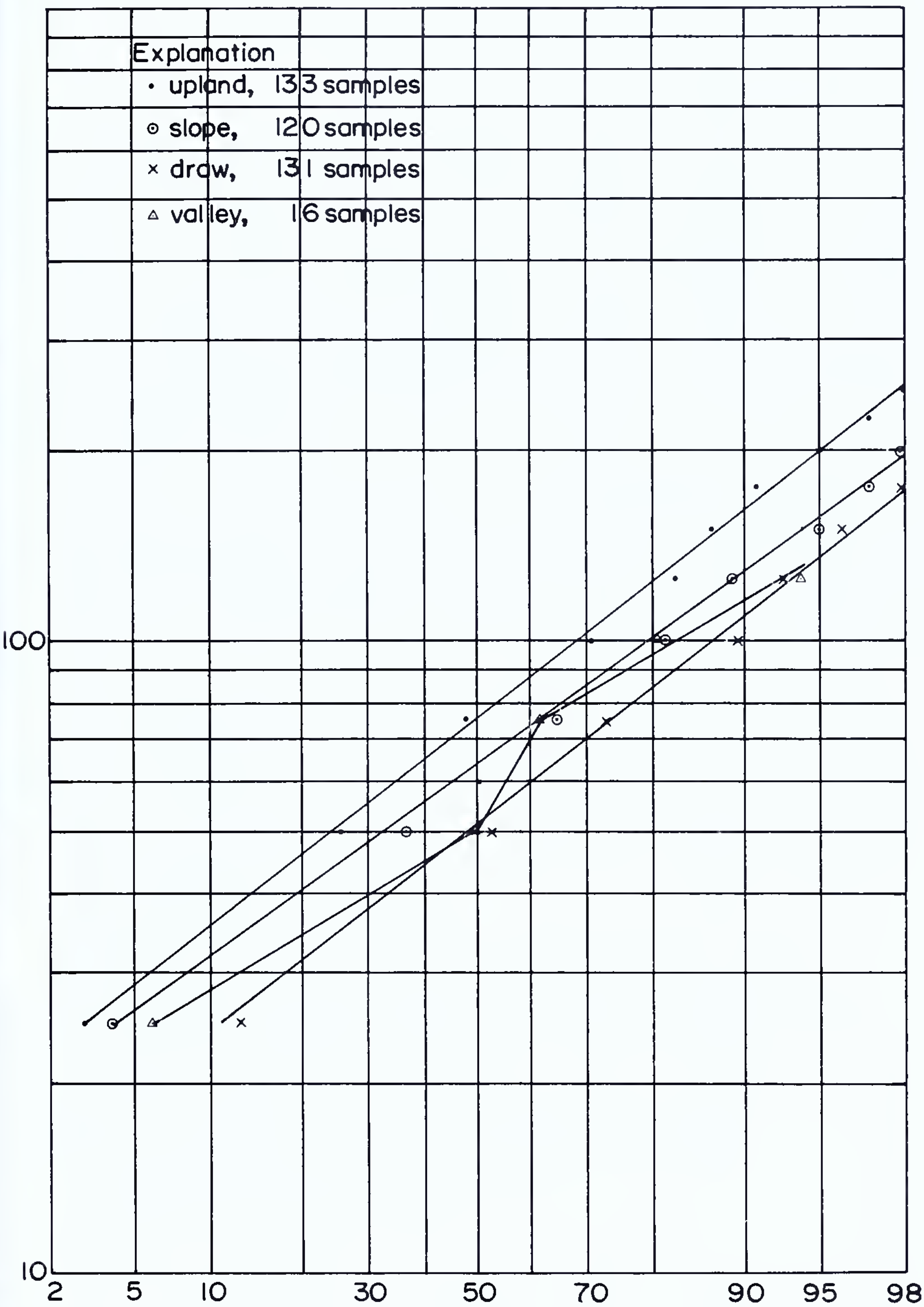


Figure 9. Graph showing the percent frequency distribution of casing depths, grouped according to topographic position.

f the wells in uplands, slopes or draws require about the same amount f casing. Those in valleys require about 8 feet more, on the average. n about 7 percent of the wells on slopes the amount of casing is greater han that in the wells in the other positions. Six of the slope wells had 150



igure 10. Graph showing the percent frequency distribution of depths of water-bearing zones, grouped according to topographic position.

feet or more casing. Four of the 6 wells were in the chlorite phase of the Wissahickon Formation.

The percentage distribution of depths of water-bearing zones below land surface is controlled to a large extent by the local topography. As shown in Figure 10, the median depth of zones in upland wells is about 75 feet, on slopes it is about 64 feet, and in draws it is about 50 feet. The distribution of the depths of water-bearing zones in valleys, based on only 16 measurements, is the same as in draws.

The range in median depth of the water-bearing zones beneath uplands, slopes, and draws differs markedly from formation to formation, as shown in the table below. In the two phases of the Baltimore Gneiss, the ranges are 22 and 19 feet; in the gabbro the range is 26 feet; in the muscovite and chlorite phases of the Wissahickon the ranges are 36 and 49 feet; and in the Peters Creek Schist it is 100 feet.

Except in the Wissahickon the median depths of the water-bearing zones are greatest in the uplands, intermediate beneath slopes, and least in the draws. In the muscovite phase of the Wissahickon the median depth is less beneath slopes than in draws; and in the chlorite phase it is greater beneath slopes than in uplands.

In summary, wells drilled in the lower topographic positions generally yield more water and obtain the water from shallower zones than do those on higher positions. Wells are shallowest in the lower positions, and it may be assumed that if all the wells were equally deep, the difference in yield between wells on uplands, slopes, and draws would be even greater. Depth of weathering, as indicated by the amount of casing, is essentially the same regardless of topography in the majority of wells.

Because data are sparse, valleys have not been discussed separately. However, they would probably fit the trend indicated above and would be slightly superior to draws as well sites.

RELATION OF METAMORPHISM TO HYDROLOGY

Metamorphism affects all the rocks of the area and intensifies toward the southeast. McKinstry (1961) delineates three zones of intensity, represented by a phyllite, a schist, and a gneiss zone (Figure 2). These zones coincide with the areas of the chlorite phase of the Wissahickon Formation, the Peters Creek Schist which is stratigraphically younger than the Wissahickon, and the muscovite phase of the Wissahickon Formation; so, it is not possible to determine definitely whether differences in the hydrologic properties of the three areas are due to the degree of metamorphism or to the primary lithologic character of the formations. However, if it is assumed that these units had the same primary lithologic character, any differences in their hydrologic properties is attributable to metamorphism. Such an assumption does appear valid as the two phases of the Wissahickon

Topographic position	All formations		Baltimore Gneiss				Gabbro		Wissahickon Formation				Peters Creek Schist	
			"Normal" phase		Gabbro-intruded phase				Muscovite phase		Chlorite phase			
	Number of wells	Median depth of water-bearing zones, in feet	Number of wells	Median depth of water-bearing zones, in feet	Number of wells	Median depth of water-bearing zones, in feet	Number of wells	Median depth of water-bearing zones, in feet	Number of wells	Median depth of water-bearing zones, in feet	Number of wells	Median depth of water-bearing zones, in feet	Number of wells	Median depth of water-bearing zones, in feet
Upland	133	75	22	68	26	63	19	67	54	88	6	62	3	150
Slope	120	64	30	58	16	50	11	56	17	52	11	103	13	62
Draw	131	50	31	46	31	44	36	41	16	66	17	54	4	50
Valley	16	50	1	35	1	87	0	. .	2	31	0	. .	0	. .

were deposited contemporaneously and the Peters Creek Schist was lai down subsequently and there is no obvious trend in their primary litholc gic properties from formation to formation.

Significant relationships seem to exist between metamorphic rank an specific capacity and depth of weathering. The median specific capacitie of the chlorite phase of the Wissahickon (the phyllite zone), the Peter Creek Schist (the schist zone), and the muscovite phase of the Wissa hickon (the gneiss zone) are 2.4, 1.0, and 0.4 gpm per ft, respectively Their depth of weathering as indicated by the amount of casing is 15 29, and 40 feet, respectively. Thus, an increase in metamorphic ranl results in a decrease in the specific capacity of the rock and an increas in its weatherability. The decrease in specific capacity is probably du to the decrease in the fissility of the rock as metamorphism increases an the minerals change from platy ones to granular minerals. The increase i depth of weathering reflects the well-known fact that minerals formed a high temperatures are less stable under near surface conditions than thos formed at lower temperatures or under conditions more nearly approxi-mating their present environment.

AREAL VARIABILITY OF HYDROLOGY

The water-bearing properties of the rocks differ from place to place within the same rock type, topographic position, or metamorphic zone. This variability is due to the inherent randomness with which the fractures bearing the water are distributed in the rocks, and has tended to obscure the effects of other factors.

An excellent example of this variability are the wells in the Ashbridge development, in the northeast corner of the area of this investigation. The wells in the following table are all in the gabbro-intruded phase of the Baltimore Gneiss, and they range in topographic position from upland to draw. Based on their topographic position the poor yields of wells 6 and 7 and the good yields of wells 12 and 13 are to be expected, but the small yields of wells 10 and 14 and the large yield of well 18 are not expected.

The capacity and depth of the water-bearing zones and the range of well and casing depths also serve to illustrate the variable character of the rocks.

On a larger scale there is an irregularity in the hydrology of the rocks that cannot be assigned to known causes. One such area is that lying south of Chester Valley in the Parkesburg and Coatesville quadrangles. Although ridge tops in general are the least desirable locations for wells, ridges in this area have been exceptionally poor—even though excellent yields have been obtained from some wells a short distance off the ridges (usually in or near draws). Figure 11 shows the approximate location and alignment of these very poor wells.

Well umber	Topographic position	Well depth (ft)	Casing depth (ft)	Well yield (gpm)	Yield of zone, gpm / Depth of zone, ft			
58-531- 6	Upland	120	23	3	1½/50	1½/69		
7	Slope	223	38	1	1/56			
8	Slope	145	21	8	8/138			
9	Slope	115	29	15	½/53	1/75	½/98	13/112
10	Slope	110	48	5	- - - - - - - - - -			
11	Slope	58	35	30	4/38	11/50	15/55	
12	Draw	93	80	24+	- - - - - - - - - -			
13	Draw	72	67	24+	- - - - - - - - - -			
14	Draw	100	34	5	½/41	1½/55	2/65	1/83
15	Draw	52	29	30+	30+/35			
16	Slope	200	34	4	4/34			
17	Upland	100	34	6	6/41			
18	Upland	70	26	31	6/32	25/60		
19	Upland	160	49	2½	2½/54			
20	Upland	100	18	5	5/97			

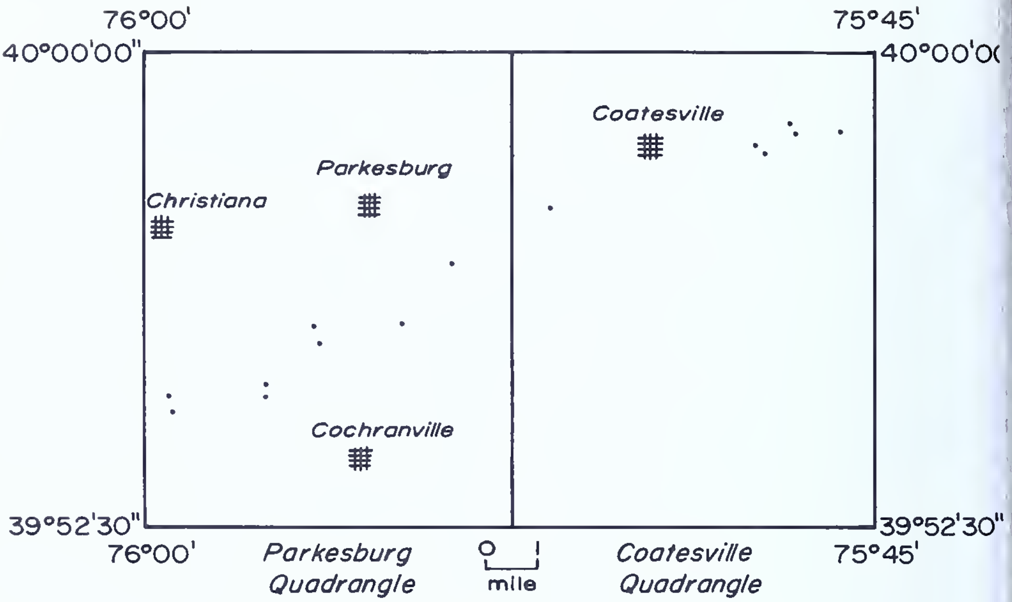


Figure 11. Map of the Parkesburg and Coatesville quadrangles showing band of poor-yield ing wells (0-3 gpm).

WATER QUALITY

Sources of Constituents

Precipitation contains small amounts of dissolved gases such as carbo dioxide, oxygen, and oxides of nitrogen. As it infiltrates through the soi zone, additional carbon dioxide is dissolved. The resultant solution slowl corrodes the soil and rock walls of the passages through which it moves The most readily soluble materials are the carbonates of calcium anc magnesium, but other ions are also taken into the ground water. The mos abundant of these other constituents, and the ones commonly determinec in most analyses, are: silica, iron, manganese, sodium, potassium, sulfate chloride, nitrate, and fluoride.

Laboratory Analyses

Samples of water from 31 wells in the project area were analyzed in the laboratory of the U. S. Geological Survey. The results of the analyses are given in Table 6.

The water was generally low in dissolved mineral matter, as the dissolved-solids content ranged from 59 to 357 ppm, and the median was 146 ppm. The calcium content ranged from 4 to 85 ppm (although only 3 samples exceeded 36 ppm), and the median was 19 ppm. The magnesium content ranged from 2.4 to 23 ppm, and the median was 8.3 ppm. The sodium content ranged from 1.5 to 36 ppm (only 1 sample exceeded 22

ɔpm), and the median was 6.7 ppm. Potassium was much less abundant ınd was fairly uniformly distributed between its extreme values of 0.2 and 7.0 ppm. The median potassium content was 1.6 ppm.

The iron content ranged from 0.03 to 7.5 ppm and the median was 0.16 ɔpm. Nine of the samples contained more than the maximum of 0.3 ppm ·ecommended by the U. S. Public Health Service (1962, p. 7) for drinkng water. Manganese was present in only 10 of the 31 samples. Five of he samples contained more than the maximum of 0.05 ppm recommended ɔy the Public Health Service (1962, p. 7).

The bicarbonate content ranged widely (from 4 to 274 ppm), and the nedian was 63 ppm. The sulfate content ranged from 0.6 to 58, and the nedian was 19 ppm. The chloride content was low in most samples; alhough the range was from 1.4 to 32 ppm, only 3 samples contained more han 20 ppm. The median was 9.2 ppm.

The nitrate content ranged from 0.0 to 76 ppm and the median was 12 ppm. Six samples contained more than 45 ppm nitrate which is the ·ecommended maximum for drinking water set by the U. S. Public Health Service (1962, p. 7).

Contaminants

In addition to the constituents derived from the geologic environment, ground water may contain various substances contributed by the activiies of man. These substances may be municipal or industrial wastes, ferilizers, cesspool or barnyard wastes, or salts that have been added to highways in winter.

The contamination of domestic wells is most readily detected by unısually high concentrations of such ions as nitrate, chloride, sulfate, and sodium, as illustrated in Figures 12 to 16.

The chloride and nitrate ions in Figure 12, and the sodium and chloride ons in Figure 16 show definite correlations. However, a poor correlation exists between the sodium and nitrate ions in Figure 14 and between the sodium and sulfate ions in Figure 15, showing that most of the nitrate ınd sulfate were not introduced into the water as sodium salts. The plot of sulfate against nitrate in Figure 13 probably represents two populaions. In one population (that containing less than about 25 ppm sulfate) he ions are independent of one another, but in the other population (that containing more than about 25 ppm sulfate) a good correlation is evident.

The scatter of points in the graphs indicates that there are slight diferences in the composition of the contaminants from well to well. For example, several of the samples have about twice as much sodium by weight as chloride; this relationship, as pointed out by Feth (1966, p. 48), is characteristic of sewage. However, one sample has much less sodium han chloride and may reflect the addition of calcium chloride to the highway.

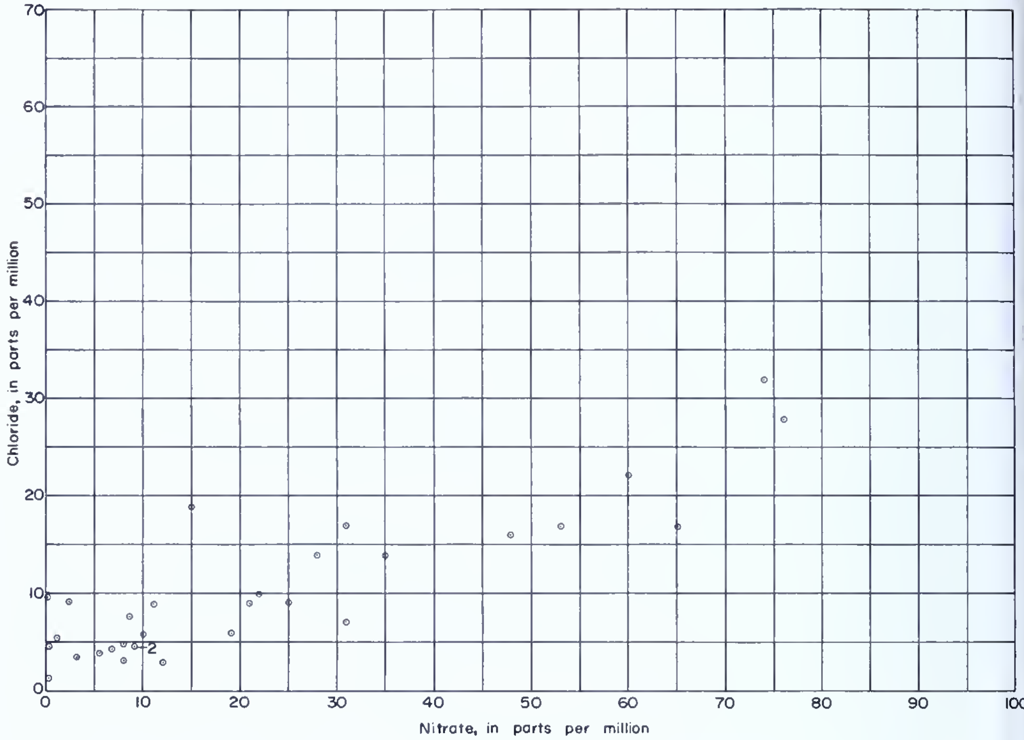


Figure 12. Graph showing the relation of chloride to nitrate. Number next to point indicates the number of sets of data having this value.

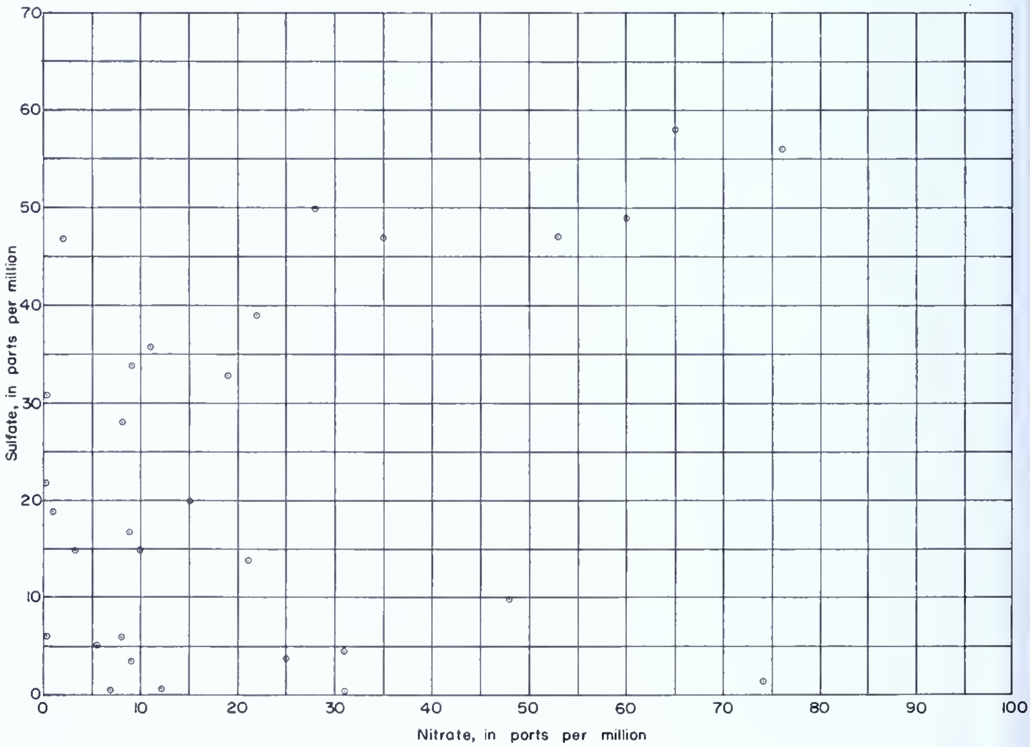


Figure 13. Graph showing the relation of sulfate to nitrate.

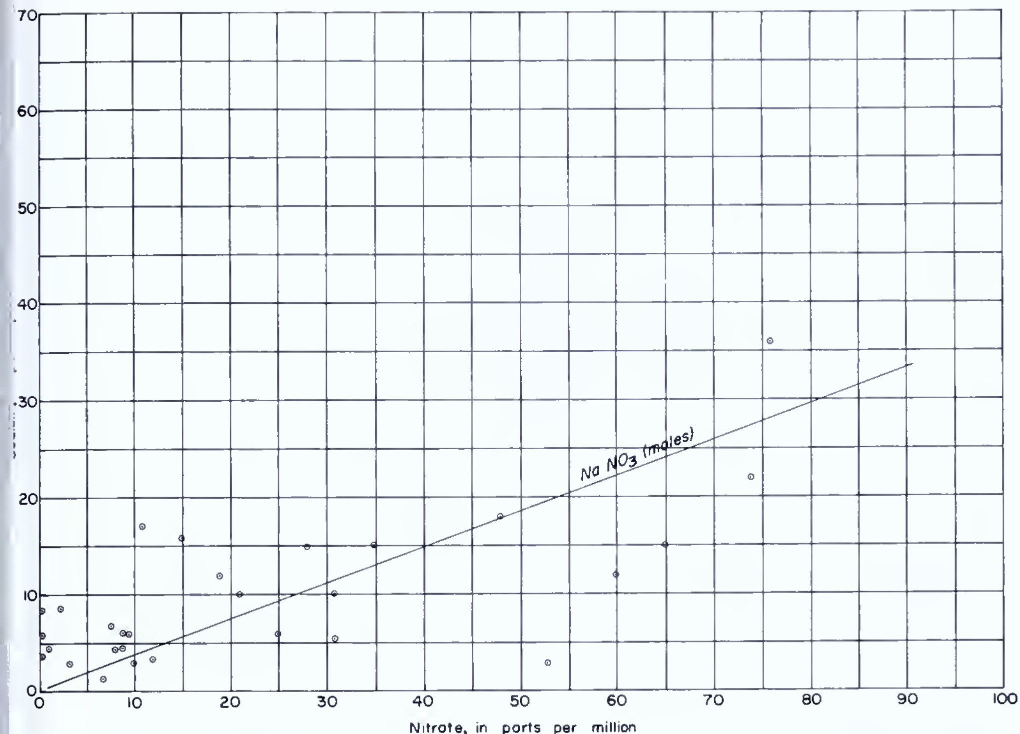


Figure 14. Graph showing the relation of sodium to nitrate.

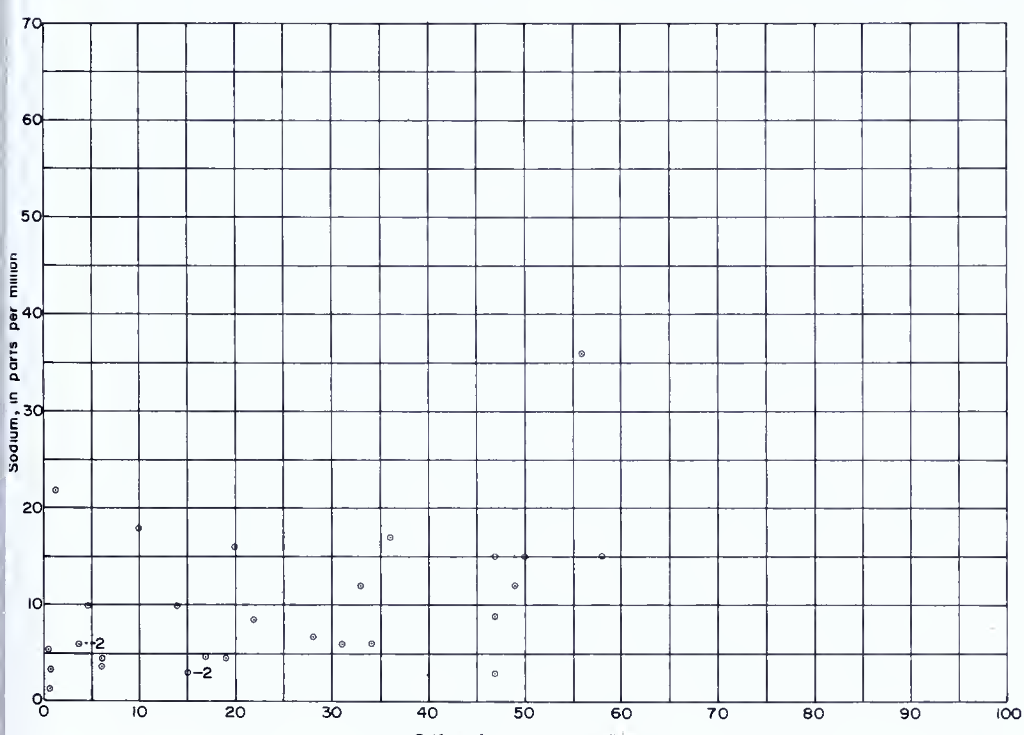


Figure 15. Graph showing the relation of sodium to sulfate. Number next to point indicates the number of sets of data having this value.

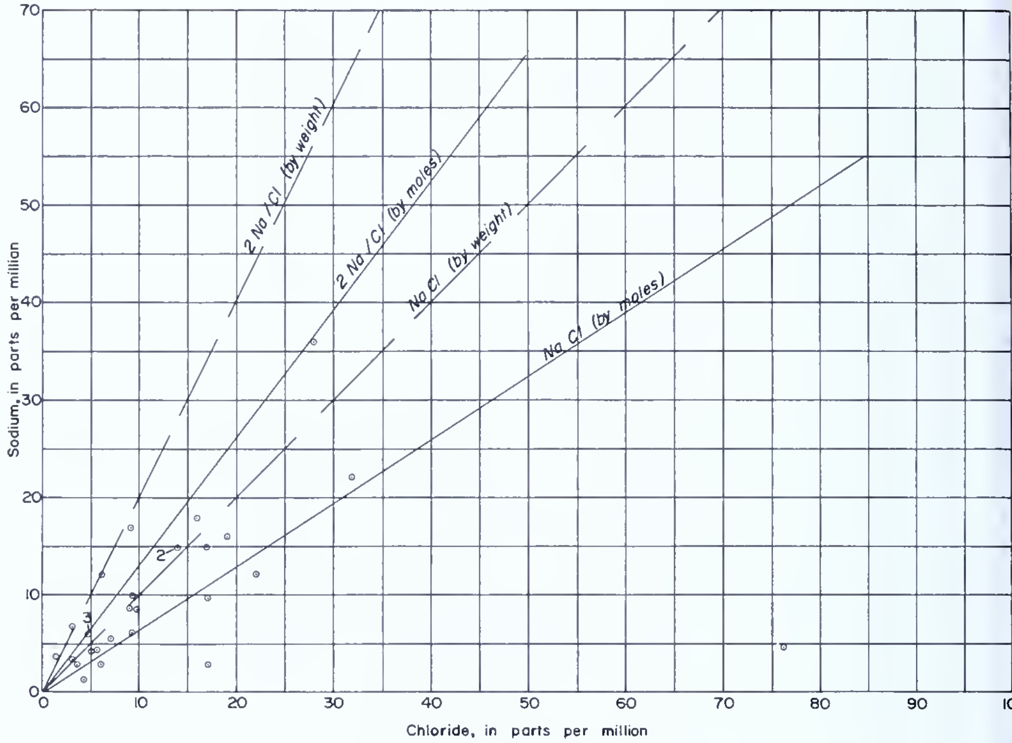


Figure 16. Graph showing the relation of sodium to chloride. Number next to point indicates the number of sets of data having this value.

The analyses are of water from different formations and from different parts of the area. The only common factor is that the water comes from a well near a home or barn. This does not mean that all wells are contaminated, as the many points that cluster about the origins of the graphs probably express the background count—that is, the amount of these ions derived from natural sources. Most cesspool or barnyard contamination is probably of local extent.

No attempt was made to collect contaminated samples. The samples were taken to obtain representative water from the different formations and from all parts of the area. It is, therefore, surprising and somewhat alarming to encounter so many samples showing evidence of contamination.

Inorganic constituents in water will travel much farther than the bacterial and organic materials. Movement is by flow down the hydraulic gradient—rather than radially, by diffusion—but it is controlled also by the directions along which the joints are oriented. Because near-surface joints are apt to be large and numerous, movement may be rapid and filtering action minimal. The distance of the source of contamination from the well is less important than its direction, for if the direction is not parallel to the strike of joints in the area (or nearly so), there may be no hydraulic connection between the source and the well.

Evidence of the rapid movement of the water through the ground was

ıoted in some of the pumping tests, as shown by Figure 17. The water vas discharged from the well through a 1-inch hose to a point nearly 100 eet away. However, in about 8 minutes it had returned to the water table ınd had begun to affect the test.

In most instances the concentrations of the nitrate, chloride, sulfate, and odium do not exceed the safe drinking-water standards of the U. S. Pubic Health Service (1962); nevertheless, above-average amounts of these ons should be taken as a warning that a potentially dangerous situation loes exist. For instance, fertilizers and wastes that tend to accumulate ıbove the water table during periods of dry weather could be flushed into he ground water by a soaking rain, thereby raising concentrations to a evel where the water would be unsuitable for drinking.

Field Analyses

Approximately 400 determinations of pH, hardness, and specific conluctance of water were made in the field. They are summarized, by geologic formation, in Table 4.

In general, the field analyses serve to broaden our knowledge of the vater of the formations. They are especially important in relation to some of the minor aquifers, where only one or two laboratory analyses are ıvailable or where the laboratory analyses are of water from contaminated vells.

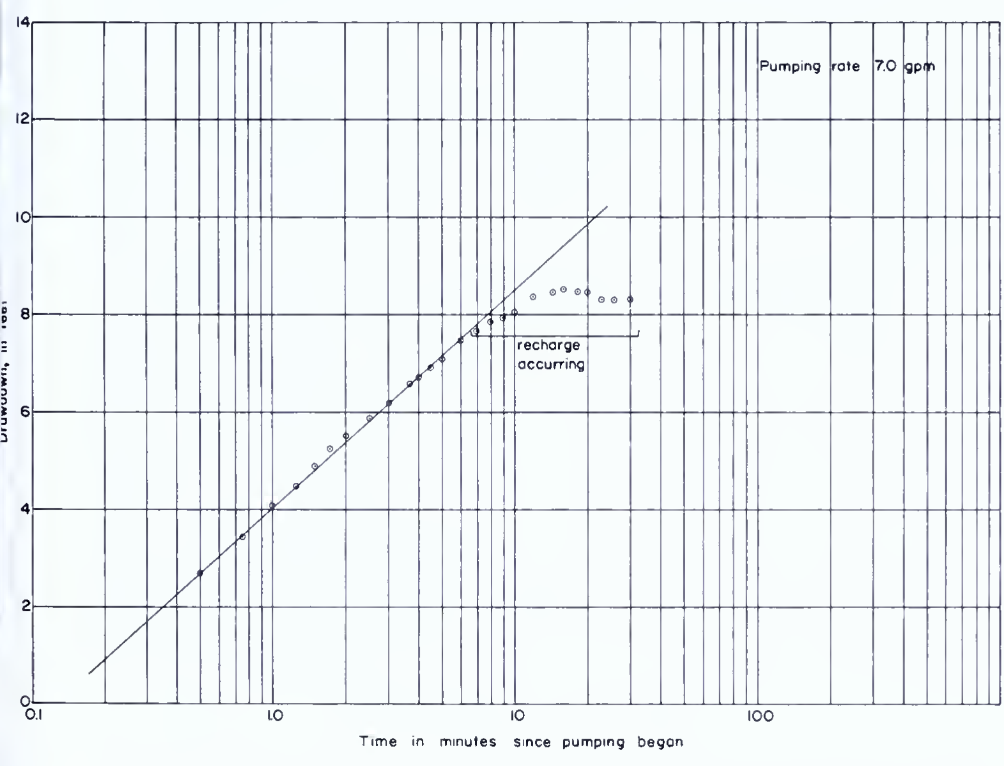


Figure 17. Graph showing the recycling of water during a pumping test in well 956-546-1.

TABLE 4.—*Summary of field analyses of water quality*

Formation	Number of samples	pH Range	pH Median	Number of samples	Hardness in grains per gallon[a] Range	Hardness Median	Number of samples	Specific conductance (micromhos at 25° C) Range	Specific conductance Median
Baltimore Gneiss									
"Normal" phase	56	5.7-7.4	6.3	72	2- 9	4	72	60-460	160
Gabbro-intruded phase	42	5.7-7.4	6.6	48	2- 9	4	48	50-575	160
Graphitic phase	3	6.1-7.3	6.6	3	5-15	6	3	290-500	325
Setters Formation	5	6.0-7.1	6.8	7	2-10	7	7	110-410	250
Cockeysville Marble	5	6.8-7.8	7.3	6	5-12	6	6	150-400	245
Wissahickon Formation									
Chlorite phase	49	5.0-7.4	6.2	55	1-11	3	54	20-370	120
Muscovite phase	58	5.1-7.3	6.2	76	1-25	3	78	25-1,150	130
Peters Creek Schist	51	4.8-7.2	6.1	52	1- 8	3	52	45-475	120
Chickies Quartzite	12	4.9-6.2	5.8	11	1- 5	2	12	20-40	125
Hellam Conglomerate Member	6	5.1-6.4	5.6	8	1- 3	2	8	15-150	75

TABLE 4.—*Summary of field analyses of water quality—Continued*

Formation	Number of samples	pH Range	pH Median	Number of Samples	Hardness in grains per gallon[a] Range	Hardness in grains per gallon[a] Median	Number of samples	Specific conductance (micromhos at 25° C) Range	Specific conductance (micromhos at 25° C) Median
Harpers Schist	4	4.7-5.7	5.5	4	1- 5	2	4	25-300	125
Antietam Quartzite	1	....	5.6	1	....	1	1	....	60
Vintage Dolomite	1	....	5.1	1	....	4	1	....	220
Kinzers Formation	0	....	..	2	6	6	2	300-350	325
Ledger Dolomite	4	6.1-7.3	7.0	4	10-28	14	4	340-1,000	488
Elbrook Limestone	1	....	7.4	1	....	14	1	....	550
Conestoga Limestone	9	5.4-7.6	7.0	9	1-18	14	9	110-640	500
Gabbro	26	5.8-7.2	6.3	30	1-22	4	30	50-700	160
Serpentine	4	6.4-7.4	6.6	5	2-15	5	5	105-510	230
Pegmatite	1	....	5.8	1	....	6	1	....	250
Diabase	1	....	7.3	1	....	5	1	....	175

[a] May be converted to parts per million by multiplying by 17.

The pH of the water is a measure of the acidity or alkalinity of the solution and is caused by the ions in solution. It ranges widely in each of the formations. The more acidic water generally comes from the Harpers Schist and the Chickies Quartzite, and the more alkaline water comes from the carbonate formations. The lowest pH measured was 4.7, for water from the Harpers Schist, and the highest was 7.8, for water from the Cockeysville Marble. In 5 percent of the samples the pH was less than 5.4, and in 5 percent it was more than 7.2. The median pH was 6.6.

Hardness in water is a measure of its resistance to sudsing and is due chiefly to the presence of calcium and magnesium ions. The field measurements of hardness are reported in grains per gallon (gpg) rather than in parts per million because the field method is accurate only to plus or minus one grain per gallon, and to state the results in parts per million would imply a false accuracy. The approximate parts per million may be obtained by multiplying the grains per gallon by 17.

Hardness ranged from a value apparently less than 1 gpg in several formations to 28 gpg in the Ledger Dolomite. The median, however, was only 3 gpg, and only 5 percent exceeded 10 gpg.

The specific conductance of a water depends on the amount and nature of its dissolved solids. The relationship of specific conductance to dissolved solids is shown in Figure 18. The scatter of the data reflects chiefly the variation in the composition of the water from well to well.

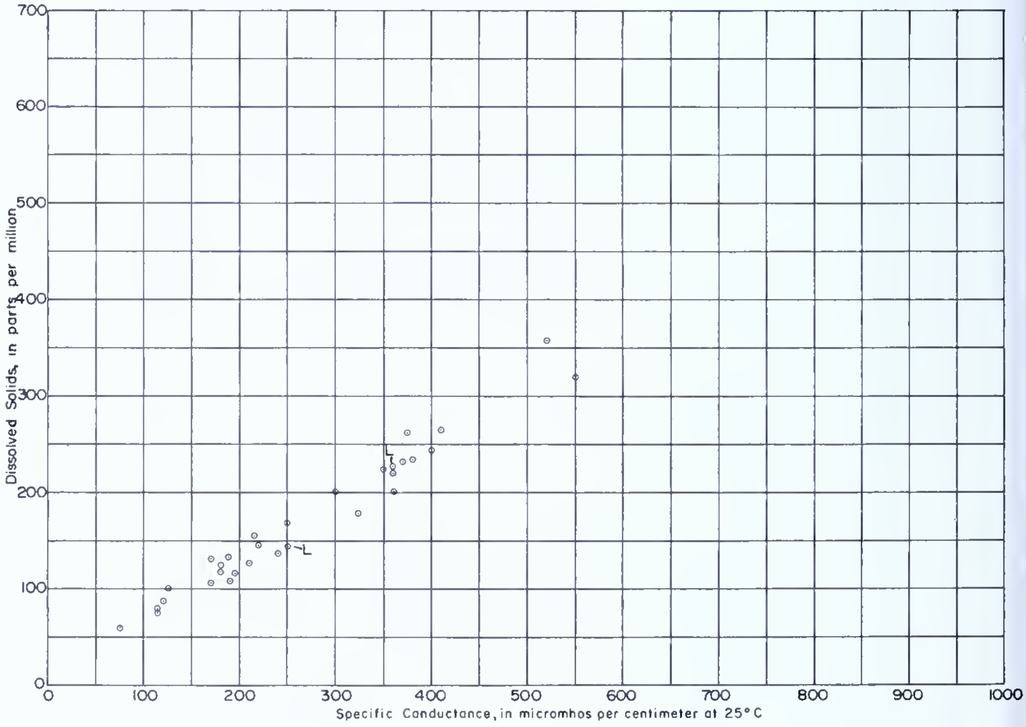


Figure 18. Graph showing the relation of dissolved solids to field specific conductance. Letter "L" indicates laboratory measurement of conductance.

The specific conductances ranged from 15 micromhos in the Hellam Conglomerate Member of the Chickies Quartzite to 1,150 micromhos in the muscovite phase of the Wissahickon Formation. They were log-normally distributed (plot as a straight line on the logarithmic-probability paper). Five percent were less than 55 micromhos and 5 percent were greater than 400 micromhos. The median was 145 micromhos.

STRATIGRAPHY AND WATER-BEARING PROPERTIES OF THE ROCKS

The stratigraphic discussion in this report is based on the work of Bascom and Stose (1932) and on that of McKinstry (1961). The geologic maps are taken from the atlas by Bascom and Stose (1932). No geologic work was done by the present writer.

The rocks may be divided into three groups on the basis of their current importance as aquifers, as indicated by availability of hydrologic data in each of them.

In the first group, called for convenience sake the major aquifers, data are sufficiently abundant to permit their appraisal. The formations of this group are the Baltimore Gneiss, the Wissahickon Formation, and the gabbro. All are of large areal extent.

The second group, called here the minor aquifers, are those on which data are not sufficiently abundant to permit their hydrologic appraisal. The formations in this group are the Setters Formation, Cockeysville Marble, Peters Creek Schist, Chickies Quartzite, Harpers Schist, Vintage Dolomite, Kinzers Formation, Ledger Dolomite, Elbrook Limestone, and Conestoga Limestone. Data are scarce in this group either because the formations are of small areal extent or because their areas are sparsely populated.

The third group, called here the local aquifers, is one in which data are almost totally lacking. This group is comprised of the Franklin Limestone, Antietam Quartzite, and the serpentine, pegmatite, and diabase. Except for the Antietam, these formations occur as small isolated bodies a fraction of a square mile in extent; the Antietam exposure is slightly larger, but is sparsely settled in this area.

Major Aquifers

The percent frequency distribution of the data on the Baltimore Gneiss, the Wissahickon Formation, and the gabbro are presented graphically; data on reported yields, specific capacities, well depths, casing depths, water-bearing zones, pH of the water, and the hardness and specific conductance of the water are shown in Figures 19 to 25, respectively

Inspection of these graphs shows a number of noteworthy features. First, the data in the two phases of the Baltimore or the two phases of the Wissahickon are not close enough to plot as a single line (the specific con-

ductance of the water in the two phases of the Baltimore is the single ex ception). Second, the data of one phase are generally more similar t those of its sister phase than they are to those of the other formations Third, many of the data are log-normally distributed or nearly so. Fourth the data on one phase of a formation often have about the same standard deviation, or rate of variability (the slopes of the lines are the same) a

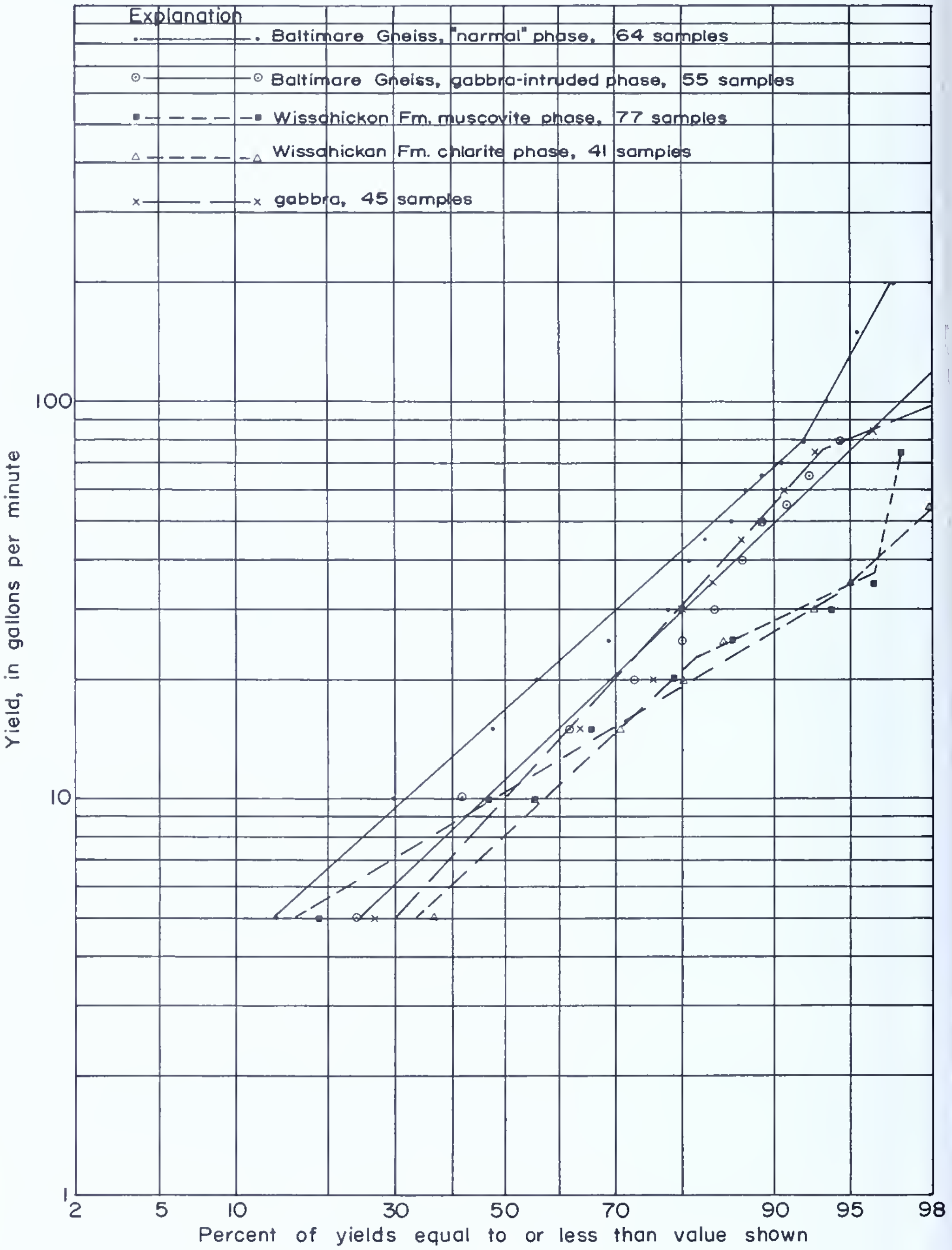


Figure 19. Graph showing the percent frequency distribution of reported well yields in the Baltimore Gneiss, the Wissahickon Formation, and the gabbro.

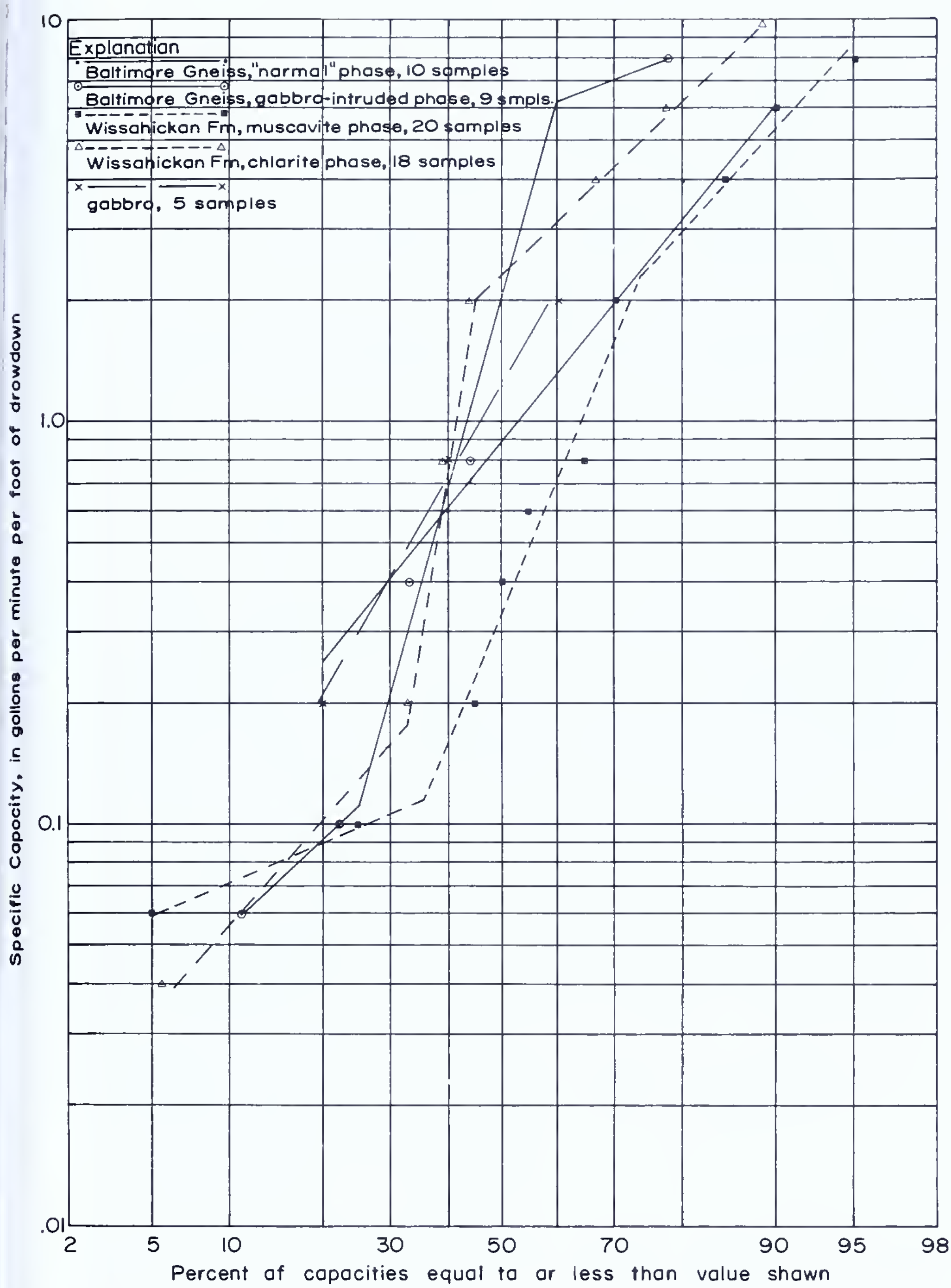


Figure 20. Graph showing the percent frequency distribution of specific capacities of wells in the Baltimore Gneiss, the Wissahickon Formation, and the gabbro.

the data from the other phase of the formation. This is especially striking in the reported yield and specific capacity graphs (Figures 19 and 20) of the Wissahickon Formation. Here the data in both phases are greatly skewed, but both curves have roughly parallel slopes that change in one phase at the same yield or specific capacity as in the other. Fifth, although

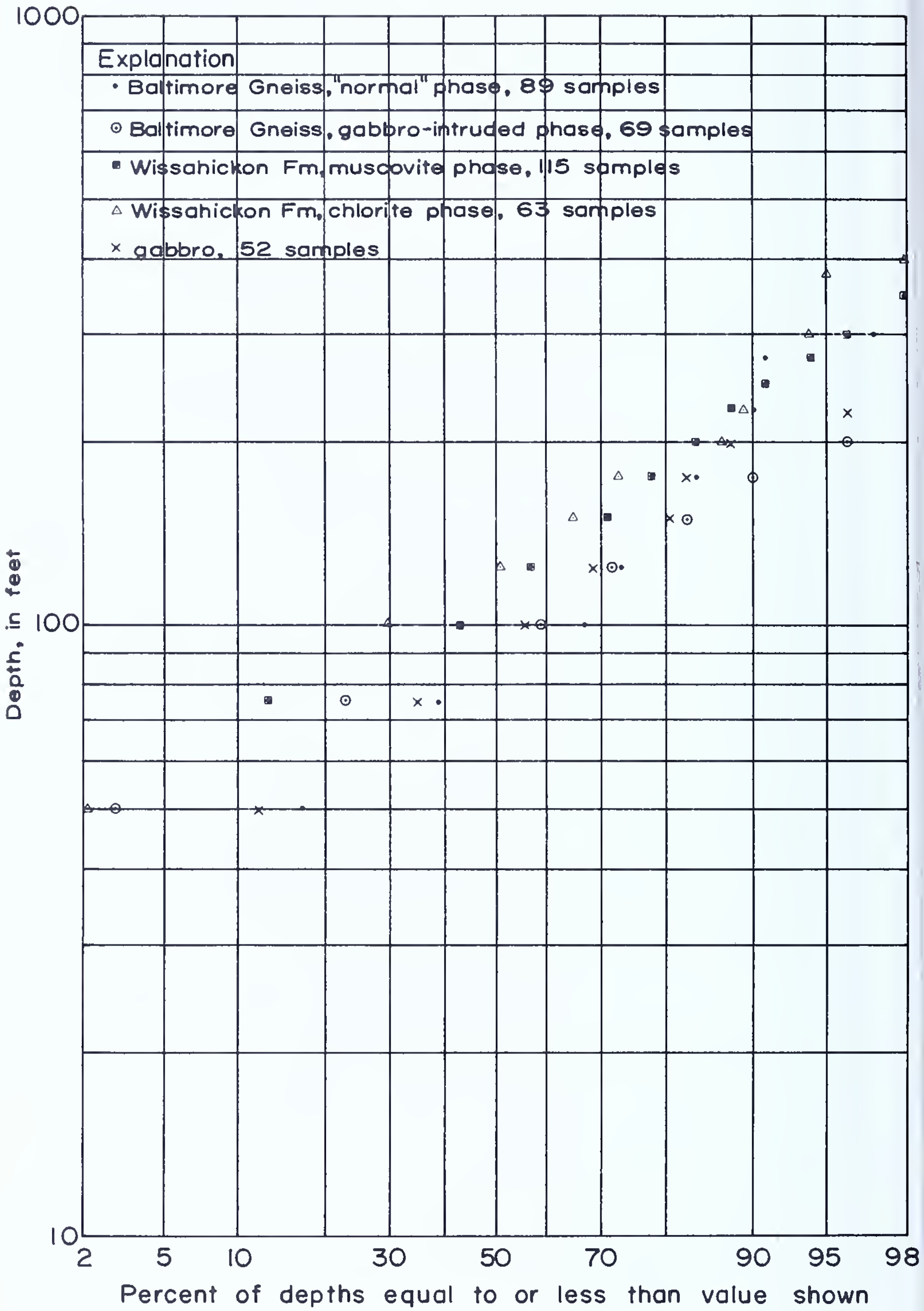


Figure 21. Graph showing the percent frequency distribution of well depths in the Baltimore Gneiss, the Wissahickon Formation, and the gabbro.

the data in the different phases or formations in most instances are sufficiently different as to plot as separate lines, their standard deviation, or rate of variability, is so great that stratigraphy is not a reliable guide to the

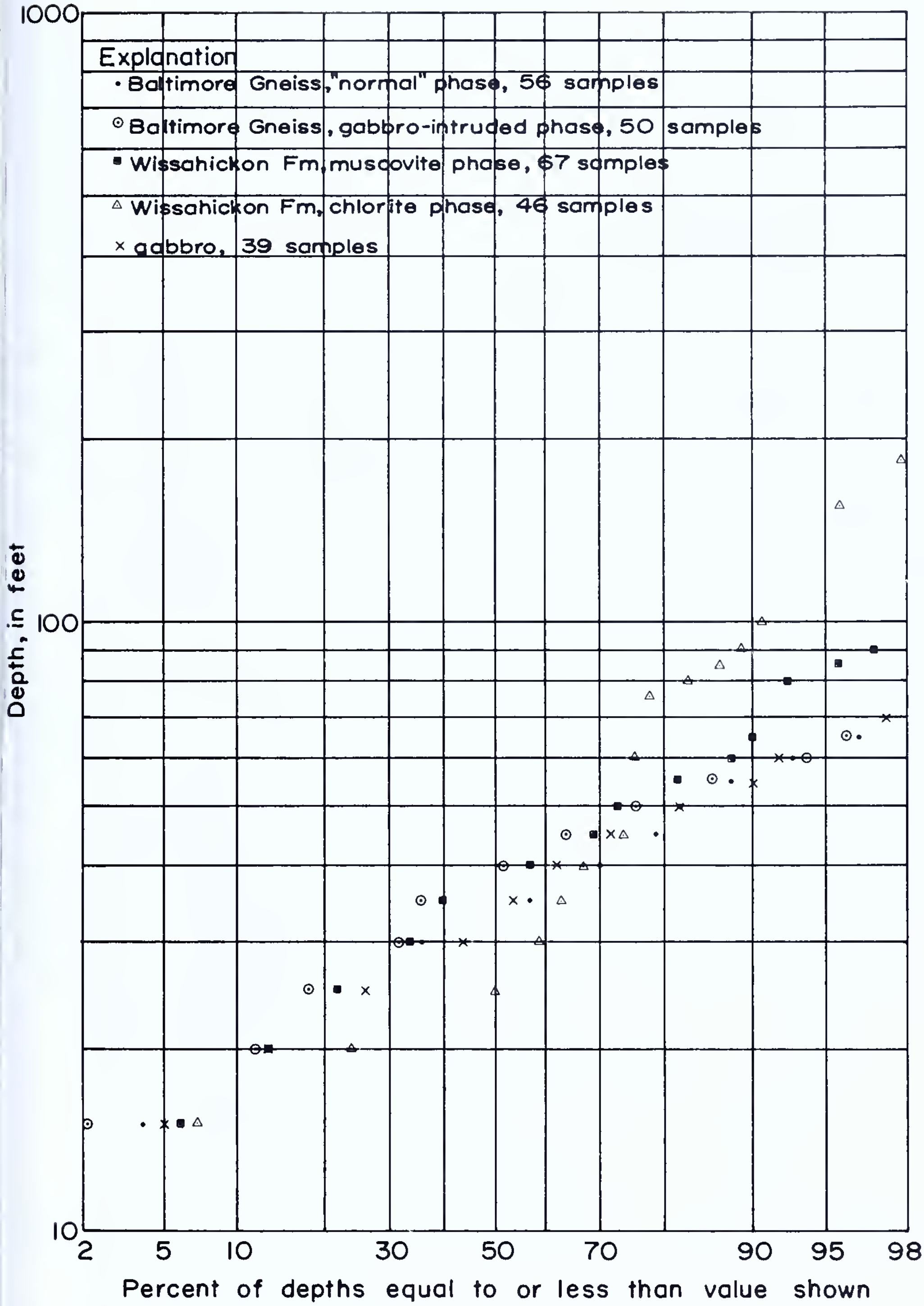


Figure 22. Graph showing the percent frequency distribution of depth of casings in the Baltimore Gneiss, the Wissahickon Formation, and the gabbro.

water-bearing properties of the rock. Sixth, the tails of the graphs of yield and specific capacity are of more interest than the middle part of these graphs. The lower ends of the graphs show the percent of the wells that

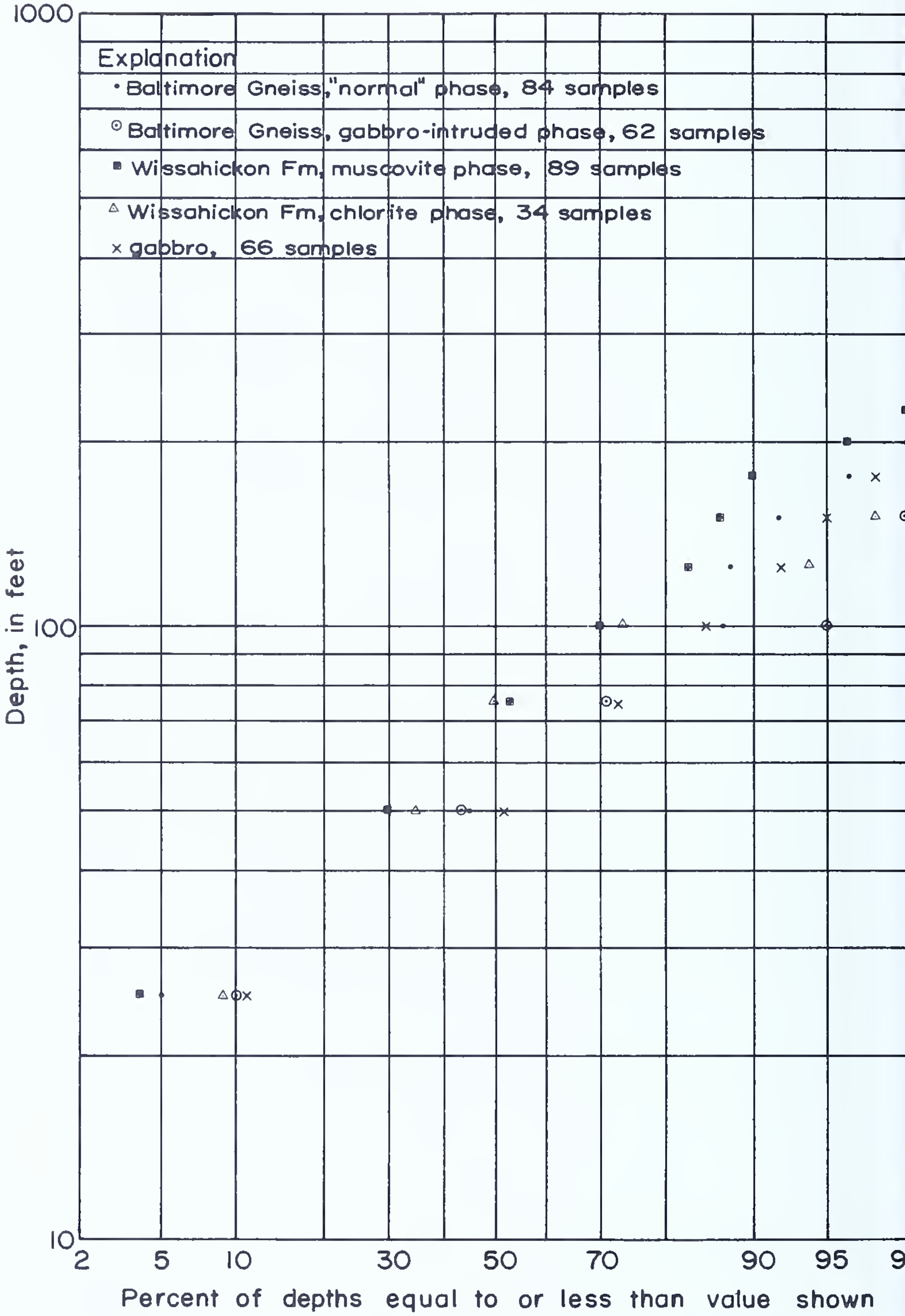
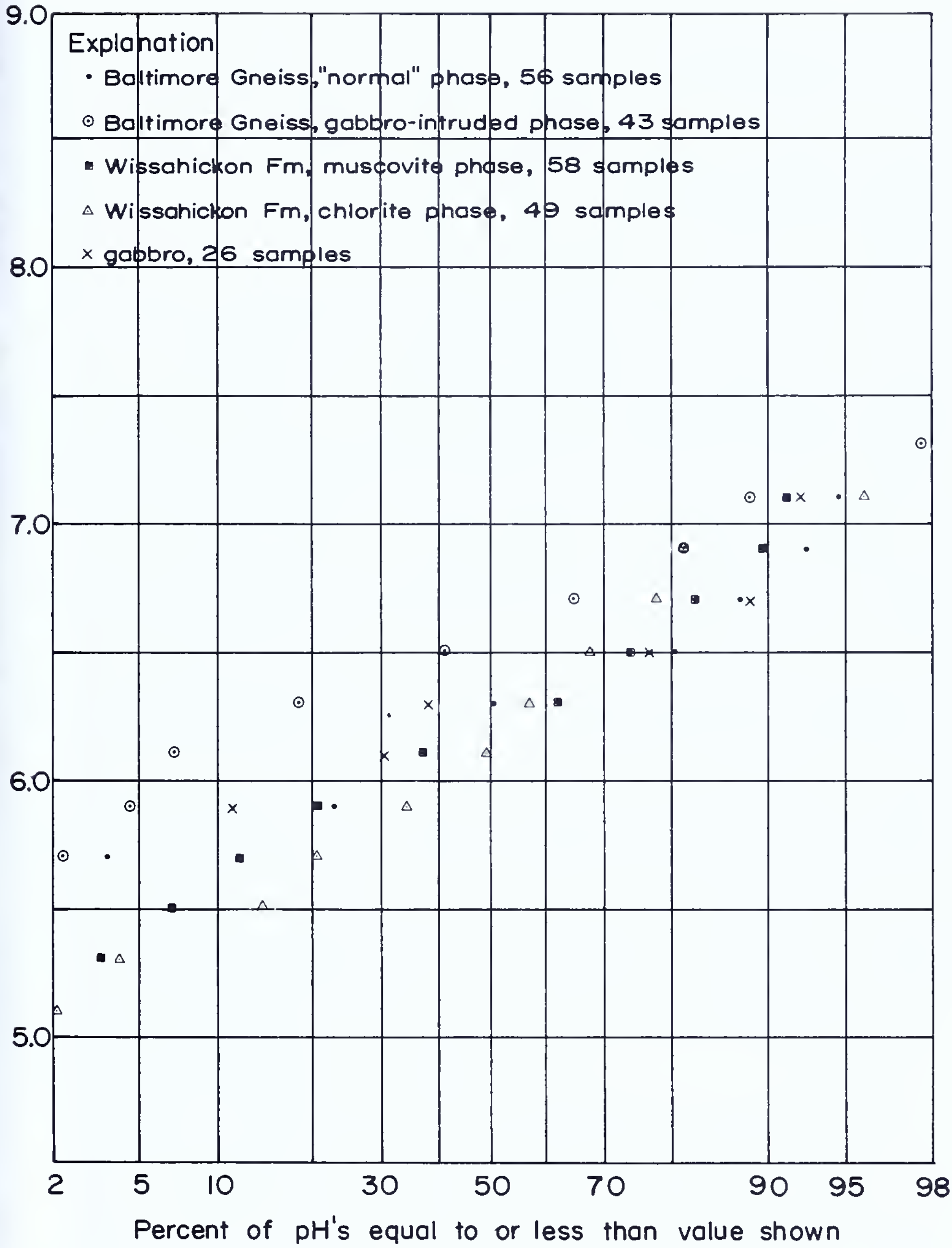


Figure 23. Graph showing the percent frequency distribution of depth of water-bearing zones in the Baltimore Gneiss, the Wissahickon Formation, and the gabbro.

failed to yield even the minimum supplies for domestic use; the upper ends of the graphs give an indication of the maximum supplies of water that may be obtained from these aquifers.



igure 24. Graph showing the percent frequency distribution of pH of water in the Baltimore Gneiss, the Wissahickon Formation, and the gabbro.

Baltimore Gneiss

Stratigraphy.—The Baltimore Gneiss is widely exposed in the cores of anticlinal structures in the area and constitutes one of the major rock ypes. It is typically a medium-grained rock containing quartz, feldspar, biotite, and occasionally hornblende.

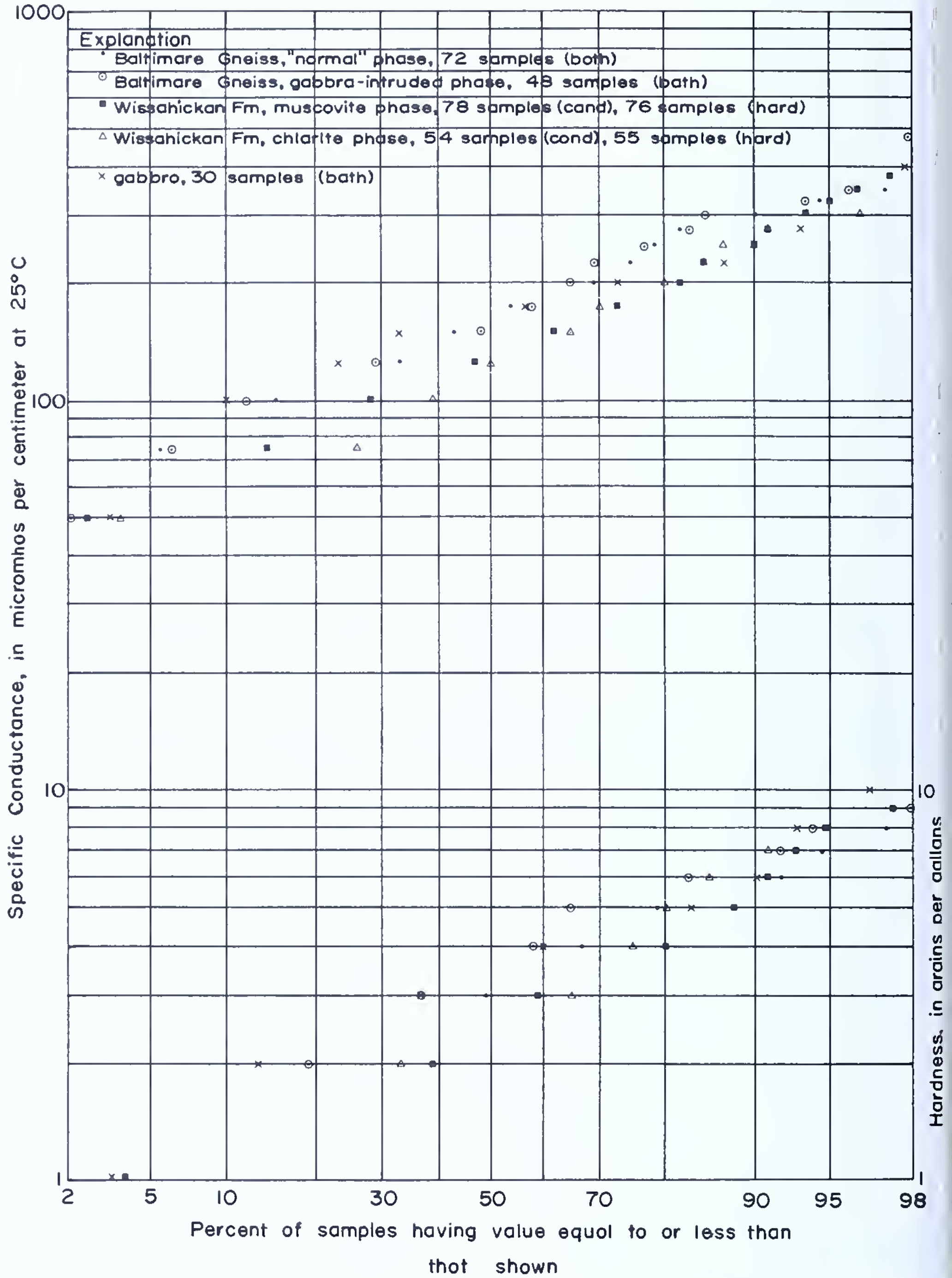


Figure 25. Graph showing the percent frequency distribution of hardness and specific conductances of water in the Baltimore Gneiss, the Wissahickon Formation, and the gabbro.

Abundant intrusions of dikes and irregular masses of pegmatite, gabbro, and peridotite—only the larger of which have been mapped—have caused the Baltimore to vary in appearance from typically banded gneiss to massive textured igneous rock.

Local shearing has altered the Baltimore to a rapidly weathering mica schist in several places such as in the vicinity of Black Horse north of Chester Valley and along a thrust fault just north of West Chester.

A graphitic phase of the gneiss of somewhat uncertain areal extent is present in the vicinity of Ward, in the southeastern corner of the area, and in a few other small scattered exposures. Both muscovite and biotite are abundant, and there is more quartz than feldspar. The graphitic phase weathers readily to a strongly hematitic or limonitic soil.

The thickness of the Baltimore is not known.

Water-bearing properties.—Reported yields obtained for 122 wells ranged from less than 1 gpm to 270 gpm. Of the 64 yields reported from the "normal" phase, 9 were 5 gpm or less and 4 exceeded 100 gpm. The median yield was about 17 gpm.

The gabbro-intruded phase of the Baltimore yielded slightly less than the "normal" phase: 13 of the 55 wells yielded 5 gpm or less and only 1 well yielded 100 gpm or more. The median yield was 11 gpm.

Yields were reported on only 3 wells in the graphitic phase of the Baltimore. These were ¼, 15, and 45 gpm.

Specific capacities based on 1-hour tests on 10 wells in the "normal" gneiss ranged from 0.2 to 8.9 gpm per ft, and the median was 0.93 gpm per ft. Tests on 9 wells in the gabbro-intruded gneiss ranged from 0.06 to 9.0, and the median was 2.2 gpm per ft. No tests were made on wells in the graphitic phase.

Of 89 wells in the "normal" gneiss for which depths were obtained, 15 were 50 feet deep or less, and 3 were over 300 feet deep. The median depth was 84 feet. Well depths in the gabbro-intruded gneiss ranged less widely. Only 2 of the 69 wells were 50 feet deep, or less, and only 3 were over 200 feet deep. The median depth was 102 feet. The 3 wells in the graphitic gneiss were 50, 145, and 154 feet deep.

The thickness of the zone of weathering in the Baltimore Gneiss, as indicated by measurements of the amount of casing used in the wells, is about the same for all phases of the Baltimore. About one-eighth of the wells penetrated 20 feet or less of weathered material and slightly less than one-eighth penetrated more than 60 feet of weathered rock. The median thickness was 35 feet.

Data on water-bearing zones were obtained from 44 wells in the "normal" gneiss, 33 in the gabbro-intruded gneiss, and 1 in the graphitic gneiss. Wells in the "normal" gneiss having either 1 or 2 yielding zones were about equally abundant and included 75 percent of the wells; 3 zones were penetrated in 20 percent of the wells, and 4 zones were penetrated in 2 wells. In the gabbro-intruded gneiss, 42 percent of the wells had only 1 zone, 27 percent had 2 zones, and 27 percent had 3 zones; only 1 well yielded water from 4 zones.

Wells 150 feet deep or less generally penetrated 2 or 3 yielding zone and 2 of these wells obtained water from 4 zones. Most of the zones wer less than 100 feet below land surface, but in the "normal" gneiss, zone were common down to 200 feet. Data on the deeper wells were scarce, bu multiple yielding zones were present in most of these wells. The zones wer much farther apart, however, than in the shallower wells. Of the 2 well deeper than 300 feet, for which data were available, both obtained som of their water below 300 feet.

Evaluation of the aquifer.—Yields of 50 gpm or more should be obtain able from wells properly situated and developed. The wells should be i draws and should be at least 100 feet deep, but probably not over 20 feet deep unless local evidence indicates the presence of deeper zones o weathering. Available data indicate that of the wells 100 feet or mor deep that are in draws, approximately 1 out of 2 wells yielded 50 gpm o more, 1 out of 3 yielded 75 gpm or more, and 1 out of 4 yielded 100 gpn or more.

Water quality.—Water samples from 5 wells were analyzed in the labora tory—3 from wells in the "normal" gneiss and 1 each from wells in th gabbro-intruded and graphitic gneiss. Dissolved solids ranged from 101 t 262 ppm. Iron ranged from 0.10 to 7.5 ppm.

Field determinations of pH were made on 100 water samples. The wate from the "normal" gneiss was the most acidic (median pH 6.3). Wate from the gabbro-intruded gneiss and the graphitic gneiss each had a mediar pH of 6.6.

The median hardness and specific conductance of 122 water sample analyzed in the field was 4 gpg and 160 micromhos in the "normal" gneis and gabbro-intruded gneiss, and 6 gpg and 325 micromhos in the graph-itic phase.

Wissahickon Formation

Stratigraphy.—The Wissahickon Formation, one of the most widesprea formations in the area, is exposed in the synclines. It exhibits the wides range of metamorphism of any of the formations, ranging from phyllite through schist, to gneiss (McKinstry, 1961, p. 562). Bascom and Stos (1932) divided it into two facies on their geologic map—a northern on known as the albite-chlorite schist and a southern one termed the oligoclase-mica schist. The relation of the northern facies to the southern facies wa not recognized at first, and the two units were considered different forma-tions and of different ages; the northern was called the Octoraro and th southern was called the Wissahickon (Swartz, 1948, p. 1507). The name Octoraro was abandoned when the two units were recognized as parts of a single formation.

The northern facies is typically a phyllite (McKinstry, 1961, p. 562) and is composed chiefly of quartz, feldspar, muscovite, and chlorite. Minute euhedral albite crystals are reported to be intercalated with muscovite schist beds (Bascom and Stose, 1932, p. 4). The bedding is rarely visible, but where seen it is nearly parallel to the cleavage.

The southern facies is more coarsely crystalline than the northern, and according to Bascom and Stose (1932, p. 4-5) is separable into two gneissic members—although they did not map it in this way. The upper member is a muscovite gneiss and, is distinguished from the lower by "being excessively micaceous . . . and more schistose than gneissic . . . (It) is characteristically crinkled or fluted, with a schistosity cutting across the fluting" (Bascom and Stose, 1932, p. 5). It is composed chiefly of quartz, feldspar, and muscovite. The lower member is developed south of the report area and is a "biotite gneiss, abundantly injected by granitic and gabbroic pegmatites and by massive gabbro . . ." (Bascom and Stose, 1932, p. 4). Feldspar is more abundant in this member than in the upper member. In the past some of this member has been mistakenly mapped as Baltimore Gneiss. Because of the intense folding and lack of recognizable recurrent beds, the thickness of the Wissahickon is not known.

Water-bearing properties.—The capacity of the chlorite phase of the Wissahickon to yield water to wells is obscured by conflicting evidence. Based on reported yields, it is one of the poorer aquifers of the area. Of 41 wells on which yields were reported, about 7 yielded less than 1 gpm and only 2 wells yielded more than 50 gpm. The median yield was about 8 gpm. However, based on specific capacities determined from 18 pumping tests, it is one of the better aquifers. Specific capacities ranged from 0.04 to 38 gpm per ft. (Only a well in the Cockeysville Marble had a higher specific capacity than the best well in this unit.) The median was 2.4 gpm per ft.

The conflict in the data is probably partly due to the improper estimation of the yields of the high capacity wells, as many of these wells were drilled by churn drill and tested by bailing. Also, it may be partly due to the failure to include a sufficient number of the poorer wells in the sampling of wells for specific capacity tests, because many of these wells were abandoned immediately after drilling, when they proved completely inadequate.

In the muscovite gneiss phase of the Wissahickon, only 1 of the 77 wells reported yielded a gallon per minute or less, and 14 yielded 5 gpm or less. Only 4 wells were reported to yield more than 35 gpm, but 2 of these exceeded 300 gpm. The median yield was 10.5 gpm.

Specific capacities of the gneiss phase were determined from tests on 20 wells and ranged from 0.06 to 8.4 gpm per ft. The median was 0.4 gpm per ft.

Of 63 reported well depths in the chlorite phase 1 was less than 50 feet deep and 4 were over 300 feet deep. The median depth was 125 feet. In the muscovite gneiss phase 2 of the 115 well depths were less than 50 feet and 5 were more than 300 feet. The median was about 112 feet.

Data on the depth of casing were obtained for 46 wells in the chlorite phase. Eight wells had less than 20 feet of casing and 4 had more than 100 feet. The median depth of casing was 25 feet. Of the 10 wells yielding 20 gpm or more, 4 had 20 feet or less of casing and 7 contained 40 feet or less. The amount of casing was not reported in 2 of the 10 wells.

Of 67 casings in the muscovite gneiss phase 9 were less than 20 feet and only 1 casing was more than 100 feet deep. The median depth was 40 feet.

Data on depth to yielding zones was obtained for 20 wells in the chlorite phase. Eleven of the wells yielded water from a single zone, 5 yielded from 2 zones, 3 yielded from 3 zones, and 1 yielded from 4 zones. Only 2 yielding zones were deeper than 125 feet although 12 of the wells were between 125 and 400 feet deep.

This distribution of water-bearing zones is markedly different in the muscovite gneiss phase. Of 40 wells, 11 obtained water from a single zone, 18 from 2 zones, 6 from 3 zones, 2 from 4 zones, 1 from 5 zones, and 2 from 7 zones. Water-bearing zones were not restricted to within 125 feet of land surface, but were at depths as great as 285 feet. One well obtained 20 gpm from a zone 252 feet deep. Contrary to expectations, no systematic decrease in the density of yielding zones was noted as the well depth increased to as much as 400 feet.

Evaluation of the aquifer.—Both reported-yield and specific-capacity data indicate a wide range in the yielding capacity of wells in this aquifer. However, for reasons noted at the beginning of the discussion on this formation, reported yields are not satisfactory for estimating the more commonly expected yields. Specific capacities were used, therefore, to estimate the potential yields of the wells, and these estimated yields were used in the following evaluation. Wells in the chlorite phase should be drilled about 150 feet deep on slopes or in draws to realize an average yield of 75 gpm or more. The wells drilled on slopes appear to yield slightly better than those in draws.

In the muscovite phase, the wells should be at least 300 feet deep for maximum production, and they may be expected to yield 75 gpm or more. Wells drilled in draws appear to be somewhat better than those on slopes.

Water quality.—Three samples of water from each phase of the Wissahickon were analyzed in the laboratory. The dissolved-solids content of the samples ranged 115 to 250 ppm and was about the same in each phase. Iron ranged from 0.03 to 0.31 ppm. The potassium content of the chlorite phase was quite low (0.2 to 0.7 ppm) and makes water from this phase readily distinguishable from water from the muscovite phase (3.0 to 3.2 ppm).

Forty-nine field measurements of pH were made on water from the chlorite phase and 59 on water from the muscovite gneiss phase. The waters were slightly acidic; their median pH was 6.2. The hardness of the water in each of the two phases was also about the same. The median hardness was 2.5 gpg. The median specific conductances were 130 and 120 micromhos.

Gabbro

Stratigraphy.—Gabbro is the most abundant of the igneous rocks in the area and is exposed both in large masses and in small elongate bodies, generally in the anticlinal areas and surrounded by the Baltimore Gneiss. A few small, scattered exposures are surrounded by the Wissahickon Formation. Bascom and Stose (1932, p. 8) state: "so closely do quartz gabbro—and the metamorphosed invaded gneiss resemble one another in color, constituents, and massive character, so irregular and confused are their contacts, that in the absence of good exposures the boundaries drawn have not the same significance as lines between well-defined sedimentary formations. The map represents the preponderance of one or another of the types rather than the exclusive occurrence of a single type."

According to McKinstry (1961, p. 560), the gabbro and metagabbro within the Wissahickon are mostly hornblende gneiss and amphibolite. The original rock type is found in the larger masses, according to Bascom and Stose (1932, p. 8) and is termed by them a hypersthene or augite gabbro. In addition to these pyroxenes, the fresh rock consists chiefly of calcic plagioclase (labradorite to anorthite) but may have as much as 30 percent quartz.

Although Bascom and Stose consider the gabbro to be intrusive, McKinstry (1961, p. 560) states that in the Wissahickon he has seen no gabbro that is clearly intrusive and suggests that it may be volcanic in origin. Furthermore he believes it may not be all the same age and that none may be post-Glenarm.

No metagabbro is found in the zone of low-grade metamorphism, but a greenstone schist that is present there may be its equivalent. The schist is composed of very fine-grained amphibole plus epidote, plagioclase, biotite, chlorite, and quartz, and would be represented in the high-grade zone by a hornblende gneiss.

Water-bearing properties.—The 45 reported yields ranged widely, from 0.5 to 125 gpm, but the median was 10 gpm. Twelve of the wells yielded 5 gpm or less, and 5 yielded more than 50 gpm.

Pumping tests were made on five wells. Their specific capacities ranged from 0.2 to 3.9 gpm per ft and the median was 1.3 gpm per ft.

The depths of 52 wells in the gabbro ranged from 36 to 235 feet. Six of the wells were 50 feet or less deep, and 6 were over 200 feet. The median depth was 94 feet.

The depths of 39 casings ranged from 10 to 87 feet, and the media depth was 33 feet. Five were 20 feet or less and 3 were more than 6 feet long.

Data from 28 wells showed that multiple yielding zones were commo in wells in this rock. Seventy-one percent of the wells yielded from mo than 1 zone, 39 percent from more than 2 zones, and 18 percent from mo than 3 zones. The fractures were more abundant at shallow depths an decreased slowly in abundance downward to about 200 feet. No wate bearing zones were encountered below this depth, although 5 of the wel were more than 200 feet deep.

Evaluation of the aquifer.—Yields of 35 gpm or more should be obtai able from wells properly situated and developed. The wells should be i draws and should be at least 200 feet deep. Data indicate that large-yiel ing zones are commonly at shallow depths, but that additional water-bea ing zones occur at depths up to 200 feet.

Water quality.—Three water samples were analyzed chemically in th laboratory. Dissolved solids ranged from 119 to 156 ppm. Iron range from 0.1 to 2.5 ppm.

The field measurements of the pH of 26 samples had a median of 6.3 The median hardness was 4 gpg and the median specific conductance wa 160 micromhos.

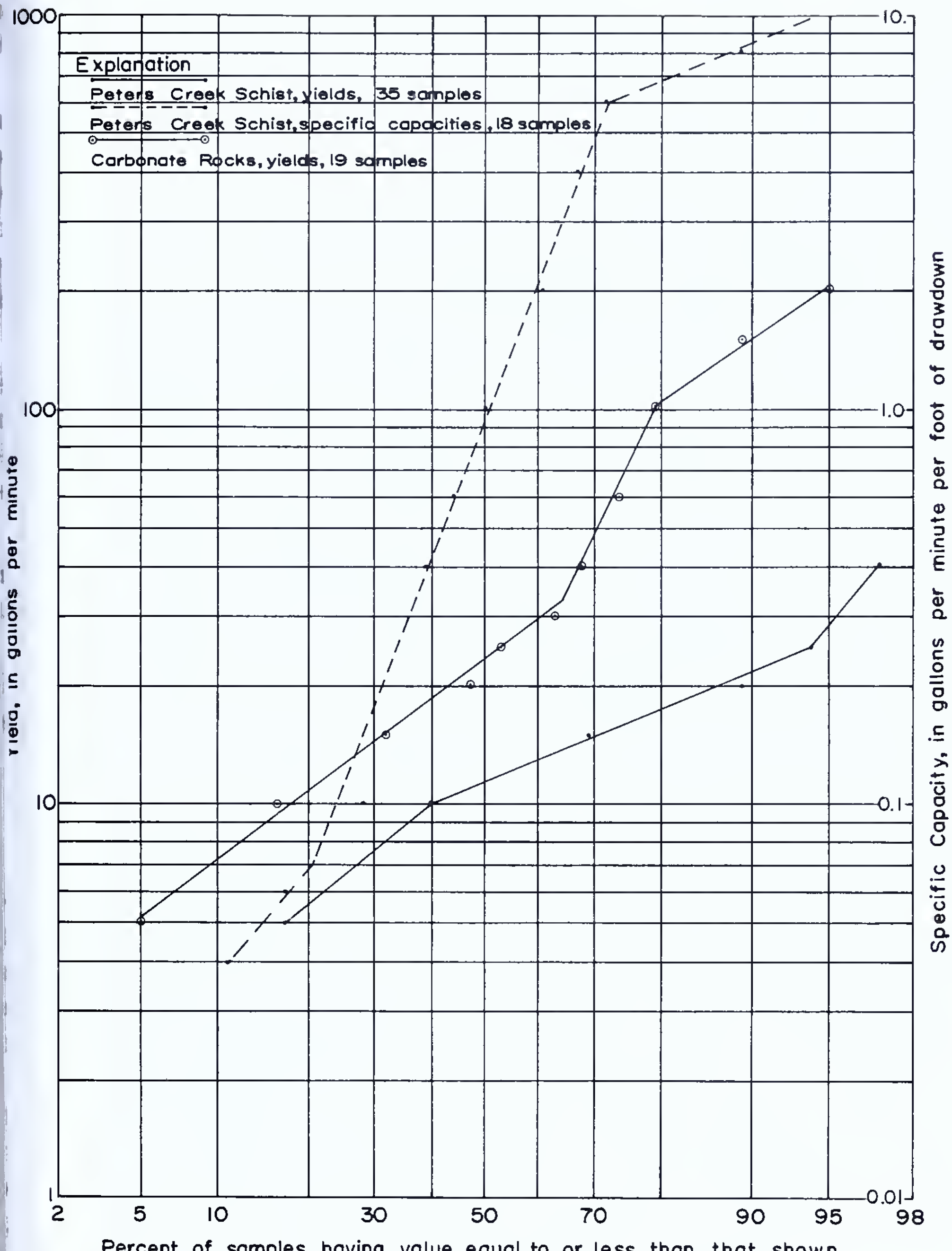
Minor Aquifers

The minor aquifers include three of the four formations of the Glen arm Series (Setters Formation, Cockeysville Marble, and Peters Cree Schist) and all seven of the Cambrian and Ordovician formations of th Chester Valley (Chickies Quartzite—including the Hellam Conglomerat Member—Harpers Schist, Vintage Dolomite, Kinzers Formation, Ledge Dolomite, Elbrook Limestone, and Conestoga Limestone).

Data were abundant enough to show percent frequency distributions onl in the Peters Creek Schist and in the combined data of the carbonate for mations. The carbonate formations were those in the Chester Valley; Vin tage Dolomite, Kinzers Formation, Ledger Dolomite, Elbrook Limestone and Conestoga Limestone.

Figure 26 shows the percent frequency distribution of reported yields i the Peters Creek Schist and the carbonate rocks, and of specific capacitie in the schist. Figure 27 shows the distribution of well depths, casing depths and depths of water-bearing zones in the schist and the carbonates. Figur 28 illustrates the distribution of pH and Figure 29 shows the distributio of hardnesses and specific conductances in these formations.

The graphs show that in general the Peters Creek Schist resembles th Wissahickon Formation hydrologically. Slight differences are present, o course: the standard deviation of the yield and depth to water-bearin



igure 26. Graph showing the percent frequency distribution of reported yields and specific capacities of wells in the Peters Creek Schist and reported yields in the combined carbonate rocks.

ones is somewhat less in the schist, as is the overall distribution of depths. Water quality is similar in both units.

In the carbonates, the yields and water quality are higher than in other ɔrmations.

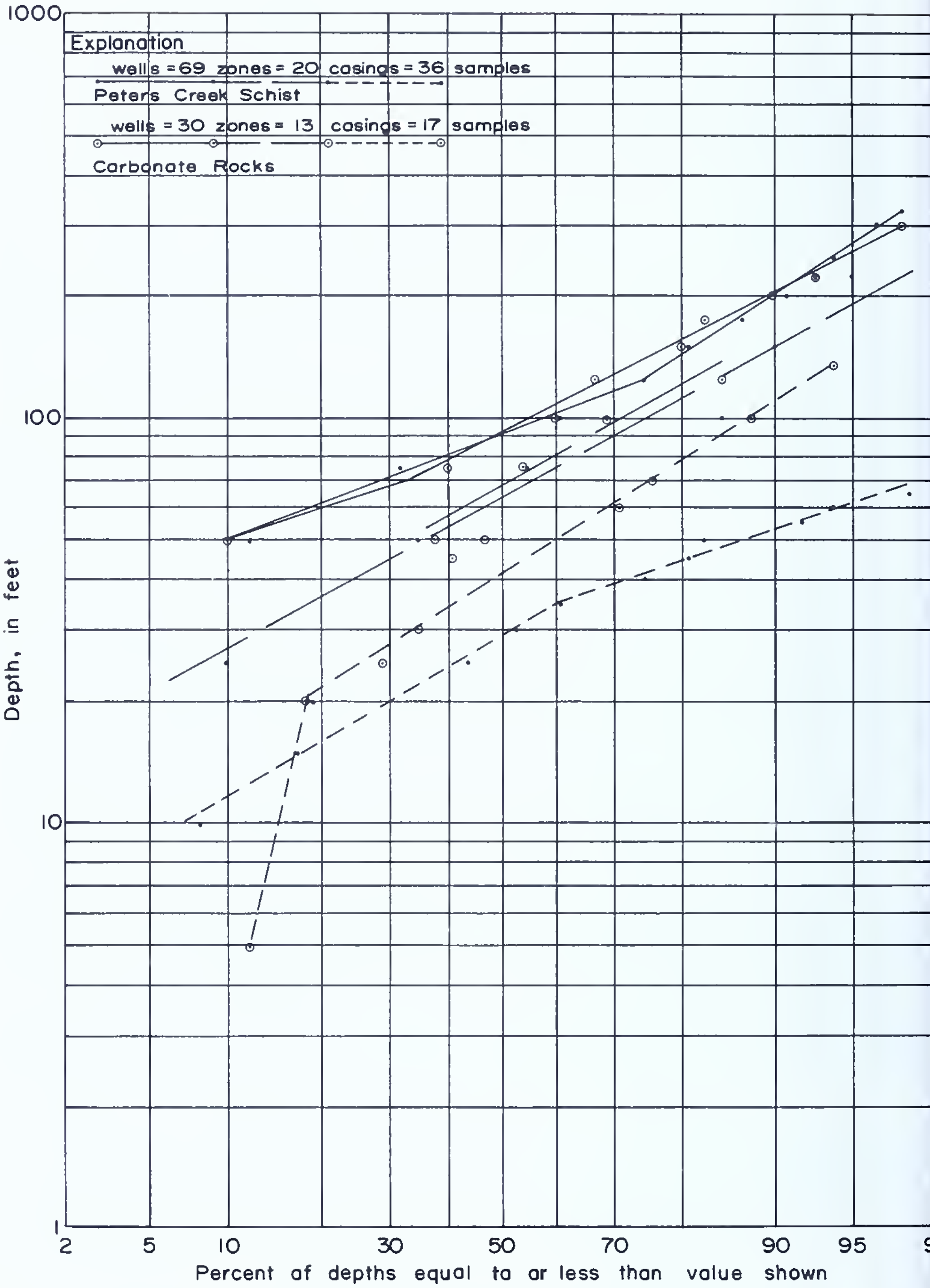


Figure 27. Graph showing the percent frequency distribution of well depths, depth of ca-ings and depth of water-bearing zones in the Peters Creek Schist and in the combined ca-bonate rocks.

Setters Formation

Stratigraphy.—The Setters Formation is present on the flanks of th Woodville and London Grove-Avondale anticlines. It consists chiefly o quartzite or quartzitic schist but in places may be a mica gneiss. Mic (chiefly biotite) may make up about half the rock or, more rarely, may b

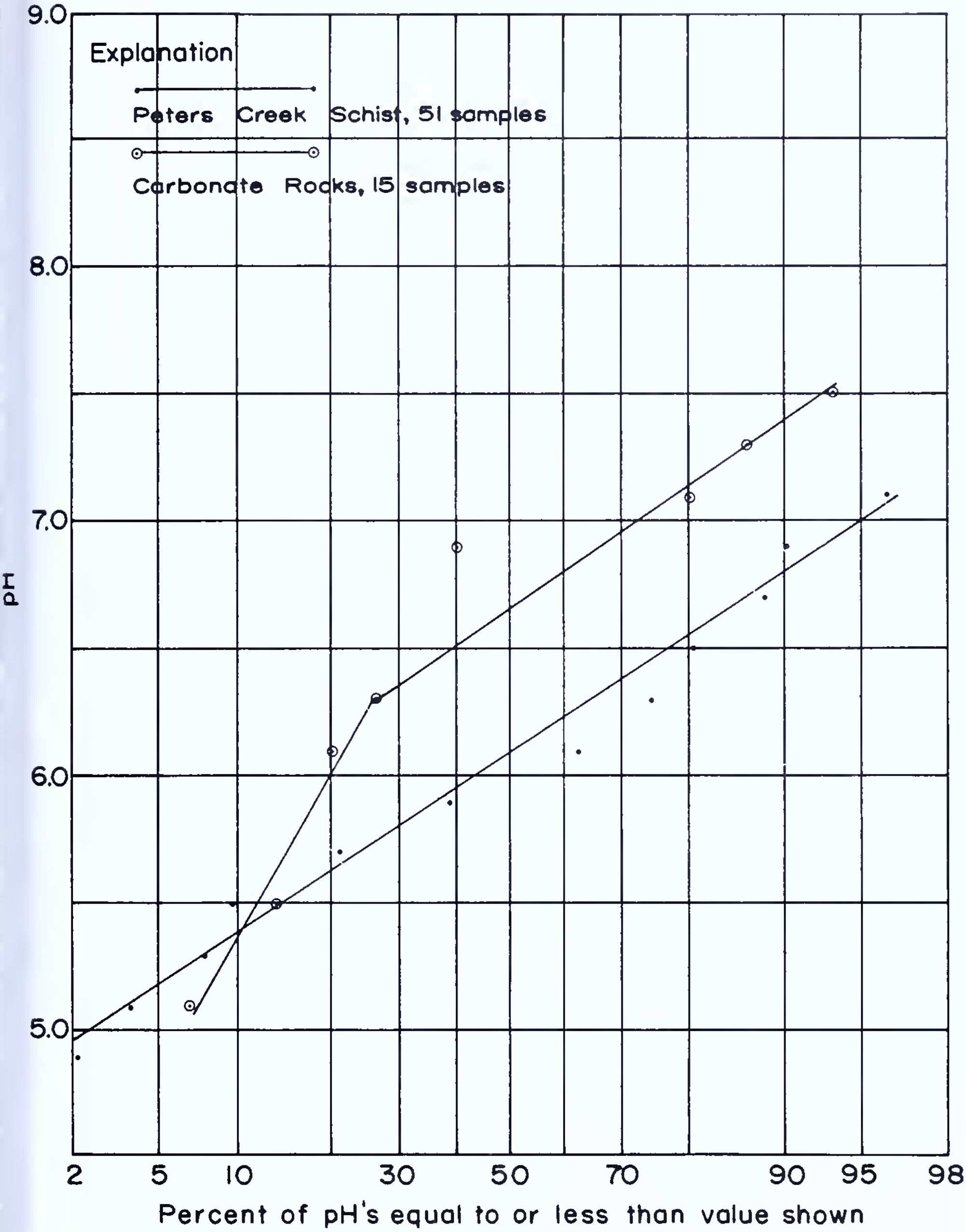


Figure 28. Graph showing the percent frequency distribution of pH of water in the Peters Creek Schist and in the combined carbonate rocks.

he least abundant mineral. The formation is considered correlative with he Chickies Quartzite and is estimated to be about 1,000 feet thick.

Water-bearing properties.—Reported yields obtained for 5 wells ranged rom 12 to 33 gpm, and the median yield was 16 gpm. Specific capacities, letermined from tests of 3 wells, were 0.2, 1.0, and 2.5 gpm per ft.

Depths reported for 8 wells ranged from 69 to 140 feet, and the median lepth was 107 feet.

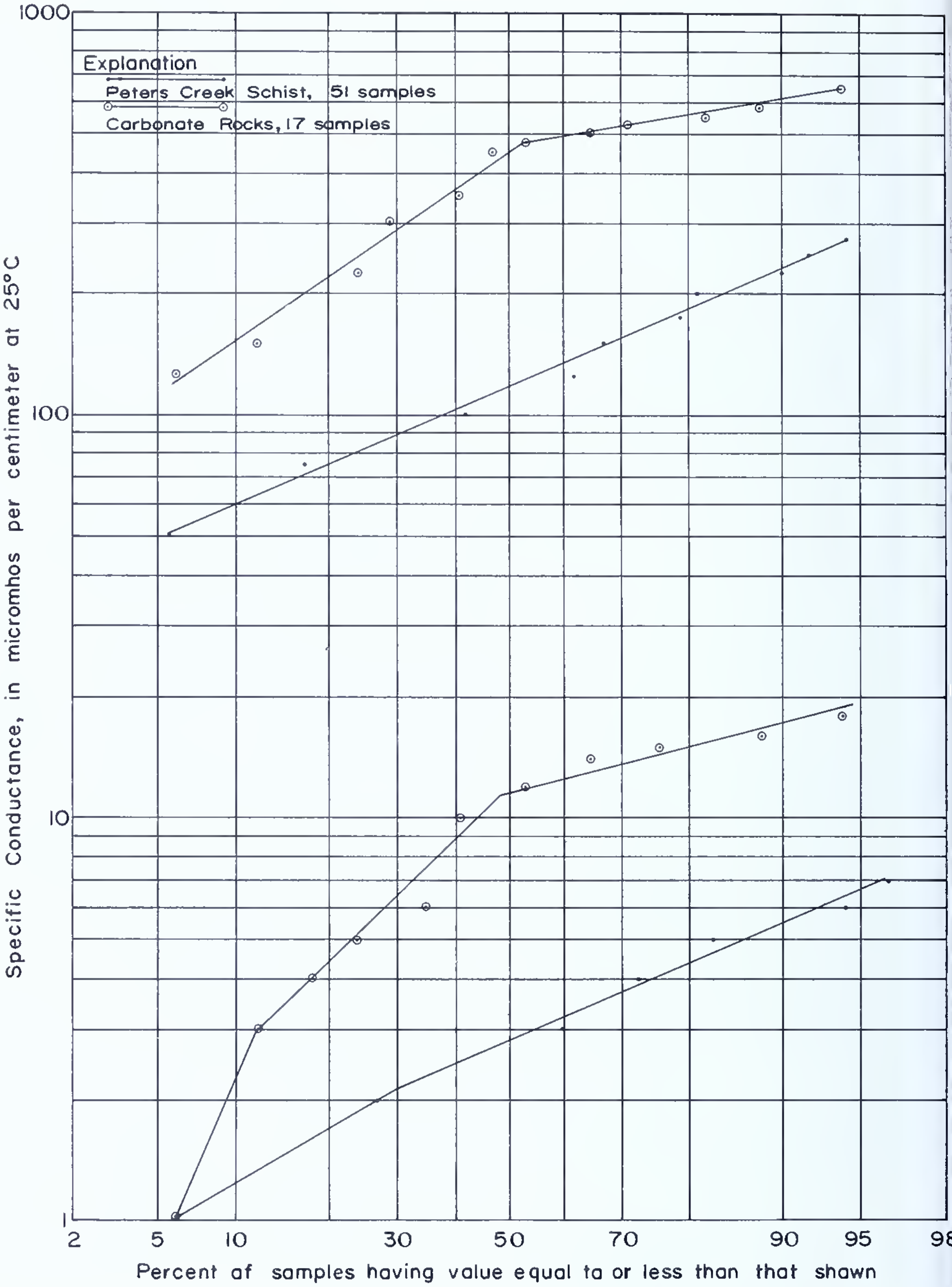


Figure 29. Graph showing the percent frequency distribution of hardnesses and specific conductances of water in the Peters Creek Schist and in the combined carbonate rocks.

Casing depths in wells in this formation ranged from 17 feet to 100 feet and apparently reflect two markedly different environments. Of the 6 wells on which measurements were available, 3 had only a small amount of casing (17, 20, and 21 feet), and 3 had much deeper casing (60, 68, and 100 feet). Whether the greater lengths indicate greater depths of weathering, zones of intense fracturing, or other factors, is not known.

Data on water-bearing zones were obtained on only four wells. Three of the wells penetrated only a single zone and 1 received water from 4 zones. The 4 zones in the one well ranged from 22 to 110 feet deep and nearly span the range in depth of the zones in the other 3 wells.

Evaluation of the aquifer.—The Setters contains few wells and is unimportant as an aquifer. The data available, however, suggest that more water could probably be obtained from wells in this aquifer than is being obtained by existing wells. The wells should be drilled in draws, and they probably should be about 200 feet deep.

Water quality.—The single sample analyzed in the laboratory had a dissolved-solids content of 265 ppm and an iron content of 0.18 ppm. This analysis is probably not typical of water in the Setters as the high nitrate (65 ppm) suggests contamination.

A more representative picture of the quality can be obtained from the [illegible] pH and 7 hardness and specific-conductance determinations made in the field. The median pH was 6.8, the median hardness was 7 gpg, and the median specific conductance was 250 micromhos. Thus, the water appears to be only slightly acidic and moderate in hardness and dissolved solids.

Cockeysville Marble

Stratigraphy.—The Cockeysville Marble is exposed on the flanks of the Woodville and London Grove-Avondale anticlines and in small areas scattered along the southern side of the Poorhouse Prong and along the Bailey lineament. It is typically a medium- to coarse-grained, saccharoidal rock, ranging in color from white to light blue-gray, and often banded with flakes of golden-brown phlogopite. It is distinguished from the Franklin Limestone by its finer texture and lack of graphite. It is distinguished from the limestones of the Chester Valley, with which it is considered correlative, by its lighter color and coarser grain. Its thickness is estimated variously from 100-500 feet (Bascom and Stose, 1932, p. 4) to 1,700 feet (McKinstry, 1961, p. 559).

Water-bearing properties.—The yield of a well in carbonate rocks depends on the size and number of the water-filled solution openings intercepted by the well. As such solution openings range widely in size and number from place to place, the well yields also range widely. This point is well illustrated by the 3 wells in the Cockeysville for which data were available. Their reported yields were 3, 20, and 330 gpm.

Specific capacities determined from tests on 4 wells were 0.1, 1.1, 5.2, and 78 gpm per ft. The specific capacity of 78 gpm per ft was the largest obtained from any formation in the area of this investigation.

Depths of 6 wells were obtained. These ranged from 33 to 170 feet; the median depth was 89 feet.

The only four reported casing depths were 20, 32, 51, and 80 feet. N relationship was apparent between the depths of these casings and t well depths or topographic positions. All except the 51-foot casing we on slopes; the 51-foot casing was in the large-yielding well which was i the valley.

Evaluation of the aquifer.—The Cockeysville is potentially the best aqu- fer in the area, and yields of 500 and 1,000 gpm or more should be o tainable. Data on optimum depths are not available; however, judgi from data obtained in other areas of carbonate rocks in Pennsylvania, n attempt to obtain a high-yielding well should be stopped short of a dep of 300 feet.

Water quality.—Two samples of water from the Cockeysville Marb were analyzed in the laboratory. Both samples contained about 230 pp dissolved solids. Although water in carbonate rocks may easily become co- taminated over wide areas, neither sample contained excessive amounts nitrate (a common indicator of organic wastes).

The water was typically slightly alkaline; the median pH of 5 sampl analyzed in the field was 7.3. Hardness (as determined in 6 samples) w moderate and included 3 samples having a hardness of 5 gpg and 3 sampl having hardnesses of 8, 9, and 12 gpg. Conductances also tend to be d- vided into two groups. Three were relatively low (150, 170, and 18 micromhos), 2 had a conductance of 310 micromhos and 1 had a co- ductance of 400 micromhos.

Peters Creek Schist

Stratigraphy.—The Peters Creek Schist is a fine-grained finely laminate nonfissile mica schist. It is characterized by numerous thin beds of quartzit which are interleaved with the layers of muscovite.

The Peters Creek is found only in the central part of the Peach Botto synclinorium. It is distinguishable, on the north, from the weakly met- morphosed phase of the Wissahickon by its abundant quartzite beds. I southern boundary, where it lies in contact with the more strongly met- morphosed phase of the Wissahickon, is uncertain. It is estimated to about 2,000 feet thick.

Water-bearing properties.—Reported yields of 35 wells ranged from to 312 gpm. Two of the wells yielded less than 2 gpm and 2 yielded mo than 25 gpm. The median yield was 11.3 gpm. Eighteen specific-capaci tests were made on wells tapping the Peters Creek Schist. The speci capacities ranged from 0.03 to 11.3 gpm per ft, and their median was 1 gpm per ft.

Reported depths of 69 wells ranged from 32 to 426 feet. Eight were feet or less deep and 6 were more than 200 feet deep. The median dep was about 92 feet.

Reported depths of casing were obtained for 36 wells; 7 were 20 feet or less deep and only 1 was more than 65 feet. The median was about 29 feet.

Depth to yielding zones was reported for 12 wells. Seven wells were supplied by a single zone, 4 by 2 zones, and 1 by 4 zones. Most of the zones were less than 100 feet below land surface, and most of the deep wells obtained their water from a single deep zone. The deeper zones did not appear to be smaller, however, as the two that were below 200 feet yielded 15 and 20 gpm.

Lithologic logs of the wells were scarce, but where data were available, they indicated that the yielding zone was usually a quartzite bed.

Evaluation of the aquifer.—The Peters Creek Schist appears to have greater potential than has yet been realized. The quartzite beds, which characterize this formation, fracture easily and serve as excellent conduits.

Although the wells inventoried were drilled chiefly for domestic supplies, nearly a third yielded 20 gpm or more and one was reported to yield over 100 gpm. Of the 9 wells yielding 20 gpm or more, 4 were less than 100 feet deep; yet, as noted above, productive water-bearing zones were intercepted below 200 feet. Yields of 20 gpm or more were obtained from wells on uplands and slopes, and in draws (no wells were inventoried in valleys). Wells in the uplands were deepest, wells on the slopes were intermediate in depth, and wells in the draws were the shallowest. For the largest supplies of water in this formation, therefore, the wells should be drilled in draws to depth of at least 300 feet.

Water quality.—Three water samples were analyzed in the laboratory. Dissolved solids ranged from 79 to 200 ppm and iron from 0.14 to 1.1 ppm.

The acidity of 51 samples was measured and the median pH was found to be 6.1. The water was generally soft (median hardness about 3 gpg), and the median conductance was about 120 micromhos.

Chickies Quartzite

Stratigraphy.—The Chickies Quartzite is a vitreous to granular quartzite that contains interbedded quartzose schist and ranges from massive to thin-bedded. The basal Hellam Conglomerate Member ranges widely in character—containing conglomerate, sandstone, arkosic schist, and black mica schist. The thickness of the Chickies is estimated to be about 500 feet, 50 feet of which is the Hellam Conglomerate Member.

Water-bearing properties.—Yields of 6 wells in the Chickies Quartzite were reported; they ranged from 2 to 20 gpm, and the median was 11.5 gpm. Determinations of specific capacity were made for 2 wells in the Chickies Quartzite; both were 0.2 gpm per ft. The 1 well tested in the Hellam Conglomerate Member had a specific capacity of 0.05 gpm per ft.

Depths of 11 wells in the Chickies ranged from 42 to 222 feet; tl median depth was 112 feet. Depths of 8 wells in the Hellam ranged fro 38 to 170 feet; the median depth was 67 feet.

Depths of casings in 9 wells in the Chickies ranged from 13 to 60 fee and the median depth was 22 feet. The one casing measured in the He lam was 74 feet deep.

The point of entrance of the water was reported for only 4 wells in tl Chickies and none in the Hellam; 3 of the wells yielded from 2 zones ar 1 from a single zone. Although 3 of the wells were less than 100 fe deep and obtained their water from 30 to 60 feet below the surface, or well struck water at 170 and 215 feet.

Evaluation of the aquifer.—The potential of the Chickies as an aquif has not been fully explored, and its importance as an aquifer is reduced b its small areal extent. The maximum yield recorded in this investigatio was only 20 gpm, but both of the wells yielding 20 gpm were shallow well Deep yielding zones are known to be present; so, in order to obtain th maximum potential yields, wells should be drilled to a depth of 300 fee

Water quality.—One water sample was analyzed from the Chickies an one from the Hellam. The sample from the Chickies contained 244 pp dissolved solids and 0.34 ppm iron; and that of the Hellam contained 5 ppm dissolved solids and 0.10 ppm iron. The relatively high concentratior of nitrate in both of these samples suggest that they also are contaminate

The median pH of 12 samples from the Chickies was 5.8; and the media pH of 6 samples from the Hellam was about 5.6. The median hardness c 11 samples from the Chickies and 8 samples from the Hellam was 2 gp The median specific conductance of 12 samples from the Chickies was 12 micromhos and the median specific conductance of 8 samples from th Hellam was 75 micromhos.

Harpers Schist

Stratigraphy.—The Harpers Schist is a gray sandy, micaceous schist con taining beds of quartz schist and thin-bedded quartzite. The thickness range widely. In the railroad cut at Atglen the thickness was estimated to be 28 feet, but a few miles north of Coatesville, in the Barren Hills, it was esti mated to be 1,500 feet. Because the Antietam Quartzite is not generall recognizable on the south flank of the Mine Ridge anticline, it is include in the Harpers. The two formations are separated in the extreme northwes corner of the area of this investigation.

Water-bearing properties.—Reported yields of 6 wells ranged from 4 t 30 gpm and the median was about 14 gpm. The single specific-capacity de termination was 1.7 gpm per ft. Reported depths of 7 wells ranged fron 28 to 160 feet and the median depth was 125 feet. Reported casing depth for 5 wells ranged from 28 to 120 feet and the median depth was 36 feet

Yielding zones were reported in only 3 wells. One well yielded from a single zone, 1 from 2 zones, and 1 from 3 zones. These zones ranged in depth from 60 to 125 feet.

Evaluation of the aquifer.—The Harpers is of small areal extent and, consequently, of minor importance as an aquifer. Wells in the formation are relatively shallow and, for the most part, are not situated in the most favorable topographic position so that the aquifer's potential is still unknown.

Water quality.—The single sample of water from the Harpers had a dissolved-solids content of 132 ppm and an iron content of 0.10 ppm. The median pH in the 4 samples tested was 5.5. The median hardness of these samples was 1.5 gpg and the median specific conductance was 125 micromhos.

Vintage Dolomite

Stratigraphy.—The Vintage Dolomite is exposed in a narrow band that trends northeastward in the Chester Valley from Coatesville, and in a small area in the northwest corner of the Parkesburg quadrangle. It is a dark-blue granular dolomite that generally has a wavy, knotted texture owing to differential weathering of impurities. The formation is usually overlain by a thick dark red mantle of residual soil.

Water-bearing properties.—Data were available on two wells. One well was 55 feet deep and yielded 3 gpm, the other was 300 feet deep and yielded 665 gpm. The difference in yields is probably due not so much to the difference in depth as to the inherent variability of the formation. The depth of casing was known only in the deeper well, where it was 208 feet. Depth to yielding zones was unknown.

Water quality.—Laboratory analyses of water from the 2 wells were similar. Dissolved solids were 116 and 144 ppm and iron was 0.34 and 0.29 ppm. The single field determination of water quality made was on the water from the shallower well: the pH was 7.6, the hardness 6 gpg, and the conductance 195 micromhos.

Kinzers Formation

Stratigraphy—The Kinzers Formation outcrops in a narrow band adjacent to the Vintage Dolomite in the Chester Valley. It is a micaceous limestone containing interbedded calcareous mica schist and is about 150 feet thick. In places the weathered rock has been quarried for building sand.

Water-bearing properties.—Data were available for 2 wells. One was 65 feet deep, the other was 147 feet deep. The shallow well yielded an unknown amount from a zone about 45 feet deep, and the deep well yielded about 10 gpm from a zone 145 feet below land surface. The deeper well had a reported depth of casing of only 4 feet.

Water quality.—Laboratory analysis of water from the shallower we showed it to have 178 ppm dissolved solids and 0.17 ppm iron. Field de terminations were made of the hardness and the conductance of the wate from each well. The hardnesses were both 6 gpg and the conductances wei 300 and 350 micromhos.

Ledger Dolomite

Stratigraphy.—The Ledger Dolomite crops out in a low, central part c the Chester Valley, northeastward from Coatesville. It is generally a pure light-gray to white crystalline dolomite, but locally it contains beds of higl calcium content. The formation is locally so massive and homogeneou that bedding planes cannot be seen. A deep red, fertile, residual soil i commonly developed on an irregular bedrock surface. The thickness of th Ledger is estimated to be 600 feet.

Water-bearing properties.—Records from 7 wells show yields rangin from 7 to 150 gpm; well depths from 42 to 400 feet and casing depth from 5 to 100 feet. Most wells yielded from a single zone and none ob tained water below 150 feet, although 2 wells were over 200 feet deep These records may not be indicative of the Ledger's potential, as industria and public supply wells tapping the Ledger in the Schuylkill River basin (east of the area of this investigation) were reported to have a median yielc of more than 750 gpm. These wells intercepted yielding zones at depths of 500 feet or more, and many of them contained more than 200 feet of casing (C. R. Wood, oral communication).

The Ledger is important as a potential aquifer in the eastern part of the Chester Valley in the area of this investigation. Wells should probably be drilled to depths of about 500 feet. Mud was reported to flow into some wells from the solution openings. These openings may have to be cased off, if special development or screening of the wells is not effective.

Water quality.—The single chemical analysis showed the water to have a dissolved-solids content of 202 ppm and an iron content of 0.06 ppm. Four field analyses were made. The median pH was 7.0, the median hardness was 14 gpg, and the median conductance was 488 micromhos.

Elbrook Limestone

Stratigraphy.—The Elbrook Limestone is exposed in a narrow band south of the Ledger Dolomite, in the Chester Valley, east of Coatesville. It is a finely laminated, fine-grained marble, containing beds of dolomite and limestone. Muscovite and sericite are present locally on cleavage and bedding planes. The rock weathers to shaly, porous fragments and to a light-yellow ocherous soil. The formation is estimated to be about 300 feet thick.

Water-bearing properties.—Yields of 15 and 150 gpm were reported from two wells that were 85 and 200 feet deep and contained 50 and 100

feet of casing. The depth to water-bearing zones were reported only on the shallower well, which yielded from two zones, 55 and 85 feet below land surface.

However, data on 13 wells in the Elbrook in the Chester Valley east of the project area indicate that the Elbrook is a poor aquifer (median reported yield of 5 gpm). The cause for the disparity of yields is not known.

Water quality.—The single sample of water from the Elbrook analyzed in the laboratory had a dissolved-solids content of 319 ppm and an iron content of 0.10 ppm. The field measurements made on this sample show a pH of 7.6, a hardness of 14 gpg, and a conductance of 550 micromhos.

Conestoga Limestone

Stratigraphy.—The Conestoga Limestone is the most widespread formation exposed in the Chester Valley in the area of this investigation. It extends the length of the valley, and west of Coatesville occupies the full width of the valley. It is a blue to gray, impure, granular, thin-bedded, micaceous limestone. Locally it ranges from argillaceous to sandy, and it may weather to a dark, sometimes graphitic, shale or to a porous sandstone. Dark partings give the weathered rock a banded or ribbed appearance. Many of the basal beds are conglomeratic, containing pebbles and large masses of marble in a limestone matrix. Because of chemical impurities in the limestone, the surface relief in the area of outcrop is greater than it is in the areas underlain by more pure limestones. The Conestoga is estimated to be at least 500 feet thick.

Water-bearing properties.—Seven of the 9 reported yields ranged from 7 to 30 gpm; the other 2 yields were 100 and 175 gpm. Specific capacities of 0.1 and 0.4 gpm per ft were obtained from one-hour tests on 2 of the lower-yielding domestic wells. The depths of the 16 wells inventoried ranged from 42 to 200 feet and the median depth was 90 feet. Only eight measurements of casing depth were obtained; the depths ranged from 18 to 134 feet, and the median depth was 49 feet.

Depth to water-bearing zones was obtained on only 3 shallow wells, each of which yielded from a single zone. They included, however, the highest yielding well inventoried in the Conestoga; a 90-foot well which yielded 175 gpm from a zone 84 feet deep.

The Conestoga cannot be completely evaluated with the data at hand because supplies adequate for the well owners were obtained at shallow depth. The aquifer appears capable of large yields, however, and wells should probably be drilled to about 300 feet in order to obtain maximum yields.

Water quality.—The single analysis of the water showed a dissolved-solids content of 357 ppm and an iron content of 0.10 ppm. On the basis of 9 field analyses, the median pH was 7.0, the median hardness was 14 gpg, and the median conductance was 500 micromhos.

Local Aquifers

The rocks comprising this group are the Franklin Limestone, the Antietam Quartzite, and the serpentine, pegmatite, and diabase. Most of the units are present only in small, isolated exposures. Data were sparse in all of the units.

Franklin Limestone

The Precambrian Franklin Limestone is a banded marble, not over 50 feet thick, and is exposed in a small area near Brinton Bridge on the Brandywine Creek. No hydrologic data were available.

Antietam Quartzite

Stratigraphy.—The Antietam Quartzite is a gray laminated quartzite and quartzose schist that is characteristically rust-spotted and stained in small depressions on the bedding surfaces. These depressions are commonly believed to be poorly preserved casts of fossil shells. The Antietam is generally indistinguishable from the Harpers Schist in this area and is mapped with the Harpers except in the extreme northwest corner of the Parkesburg quadrangle. Its thickness is not determinable in the Parkesburg quadrangle; but in the Barren Hills, a few miles to the northeast, the thickness is estimated to be 150 feet.

Water-bearing properties and water quality.—The Antietam is unimportant as an aquifer because it is sparsely settled in this area and no wells were found in the formation. A field analysis was made, however, of the water from a spring; the pH was 5.6, the hardness 1 gpg, and the conductance 60 micromhos.

Serpentine

Stratigraphy.—Serpentine is present in many small isolated exposures. Associated exposures are believed by Bascom and Stose (1932, p. 8) to be part of a single body. They cite as evidence that wells drilled into serpentine at the Westtown School lie along strike and 1 to 2 miles distant from exposures of serpentine to the southwest and northeast. McKinstry (1961, p. 560) notes that serpentine usually occurs along zones of regional shearing and is itself strongly sheared.

Serpentine is a magnesium-rich rock derived from pyroxenite (a nonfeldspathic pyroxene-bearing rock) and from peridotite (a nonfeldspathic olivine-pyroxene rock). The serpentine derived from pyroxene is usually somewhat fibrous and that derived from olivine is massive. Serpentine generally weathers less readily than the other rocks; thus, it forms low hills and ridges that are mantled by a thin, low-fertility soil.

Water-bearing properties.—The yields reported for 4 wells in the serpen-ine ranged from 4 to 80 gpm, and the median was 18 gpm. The one well on which a pumping test was run had a specific capacity of 0.6 gpm per t. Depths of 5 wells ranged from 40 to 310 and had a median depth of 104 feet. Casing depths of 15 and 108 feet were also obtained.

Water-bearing zones were known in 2 wells. One yielded from a single zone at 45 feet and the other from three zones at depths of 58, 107, and 154 feet.

The serpentine appears to be capable of yielding small to moderate sup-plies of water. The wells should probably be at least 200 feet deep.

Water quality.—The single water sample analyzed in the laboratory had a dissolved-solids content of 221 ppm and an iron content of 0.07 ppm. Four pH and five hardness and conductance measurements were made in he field. The median pH was 6.6, the median hardness was 5 gpg, and the nedian conductance was 230 micromhos.

Pegmatite

Stratigraphy.—Pegmatite is abundant in the area as sill-like bodies which generally have a strike similar to that of the enclosing formation and a dip pproximately that of the schistosity of the formation. In many places it s exposed as a series of lenses rather than as a continuous body. In addi-ion to the mapped bodies of pegmatite, Bascom and Stose (1932, p. 9) ote that "... there are innumerable paper-thin injections of pegmatite in he gneiss, which completely alter the character of the invaded rock. . .".

The pegmatite ranges in composition from that of granite to gabbro and an be distinguished from these rocks by its coarser grain, irregular texture, nd (occasionally) by the presence of rare minerals.

In the Wissahickon the pegmatite occurs in the middle and high grade ones of metamorphism (McKinstry, 1961, p. 560) and is reportedly of ocal derivation, as the lenses have the same composition as the surround-ng rock. Pegmatite seems to be absent from the zone of low grade meta-norphism, but lenses similar in shape to the pegmatite lenses of the more netamorphosed zones are present and consist of quartz, calcite, and albite.

Water-bearing properties and water quality.—Although the pegmatite ills are widespread, they are quite small; so, the pegmatite is unimportant s an aquifer. Only one well was found that penetrated this rock. The depth of the well was 100 feet. A field analysis showed the water had a pH of .8, a hardness of 6 gpg, and a specific conductance of 250 micromhos.

Diabase

Stratigraphy.—Several dikes of diabase strike northeastward across the rea. One prominent dike leaves the area of this investigation near Coates-

ville and another leaves the area northeast of West Chester. The diabase a medium- to fine-grained rock composed chiefly of plagioclase and py roxene in equal amounts. It is Triassic in age.

Water-bearing properties and water quality.—The diabase is small i areal extent and, so, unimportant as an aquifer; also, it is dense and har to drill, and only domestic supplies are obtainable. The single well recor obtained from diabase in this area was that of a well 255 feet deep th yielded a half gallon per minute from a depth of 70 feet. The water had pH of 7.3, a hardness of 5 gpg, and a conductance of 175 micromhos.

Reports from adjacent areas indicate that this is a somewhat poore yield than normal, and that yields of about 5 gpm are more typical of th diabase.

CONCLUSIONS

The ground water occurs in and moves through fractures in the rock Most of these water-bearing zones are less than 200 feet below the su face, but some in the Baltimore Gneiss are deeper than 300 feet. Well commonly intercept two or more zones.

Wells in draws and valleys yield more than those on slopes and upland and are generally shallower.

Depth of weathering, as indicated by casing lengths, is not affected b topographic position. The importance of the weathered zone as a reservoi appears to be restricted by the abundance of clayey material.

The influence of metamorphism is shown by a decrease in well yield an an increase in depth of weathering as the metamorphic rank of the rock increases from slate to gneiss.

The water is of the calcium magnesium bicarbonate type. It is slightl acidic—having a median pH of 6.6—and is soft, having a median hardnes of 3 gpg. The median dissolved-solids content is 146 ppm.

Large yields were obtained from several of the formations. These maxi mum yields were 270 gpm from the Baltimore Gneiss, 330 gpm from th Cockeysville Marble, 350 gpm from the Wissahickon Formation, 312 gpn from the Peters Creek Schist, 665 gpm from the Vintage Dolomite, 15 gpm from the Ledger Dolomite and Elbrook Limestone, 175 gpm from th Conestoga Limestone, 125 gpm from the gabbro, and 80 gpm from th serpentine. Although these yields are not typical of the yields that may b commonly expected, they are more indicative of the potential of thes rocks than the median yields of the domestic wells that provided the bul of the data available.

Data were not sufficiently abundant for adequate appraisal of the Setter Formation, Chickies Quartzite, Harpers Phyllite, Antietam Quartzite, Kin zers Formation, pegmatite, and diabase.

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Table 5. Record of drilled wells

Well number: See text for description of well-numbering system.
Aquifer: Conestoga Limestone, Oc; Elbrook Limestone, Ce; Ledger Dolomite, Cl; Kinzers Formation, Ck; Vintage Dolomite, Cv; Antietam Quartzite, Ca; Harpers Schist, Chp; Chickies Quartzite, Cc; Chickies Quartzite, Hellam Member, Ch; Peters Creek Schist, Xpc; Wissahickon Formation, chlorite phase, Xwc; Wissahickon Formation, muscovite phase, Xwm; Cockeysville Marble, Xc; Setters Quartzite, Xsq; Franklin Limestone, pCf; Baltimore Gneiss, "normal" phase, pCbn; Baltimore Gneiss, gabbro-intruded phase, pCbgb; Baltimore Gneiss, graphitic phase, pCbgg; diabase, Trd; gabbro, Xg; serpentine, Xs; pegmatite, Xp.

Use: A, abandoned or unused; D, domestic; I, industrial; O, observation; P, public supply; S, stock.

Well number	Owner	Driller	Date completed	Altitude above sea level (feet)	Diameter of casing (inches)	Total depth (feet)	Depth to bottom of casing (feet)	Depth to water-bearing zones (feet)	Aquifer	Static water level: Date measured	Static water level: Depth below land-surface (feet)	Reported yield (gpm)	One hour specific capacity (gpm/ft)	Use	Field analyses of water: pH	Field analyses of water: Hardness (gpg)	Field analyses of water: Specific conductance (micromhos at 25°C)
	Chester County																
952–536–1	Thomas Jenks	Artesian Well Drilling Co.	1955	265	6	65	40	65	pCbn	1955	1	62		D			
537–1	David Clark	Charles Lauman	1963	300		62			pCbn					D	6.9	5	190
538–1	A. van Roggen	Delaware Valley Well Drilling Co.	1963	415	6	120			pCbn	Oct. 1963	83	15		D	6.0	3	120
2	L. M. Sherman	Walton Well Drilling Co.	1963	395	6	220	31		pCbn	Apr. 1963	81	12		D		5	185
539–1	Mytle Higgins			330		35			pCbn	Oct. 1964	5	60		D		2	130
540–1	Longwood Farms			360	8	110			Xsq	Dec. 1950	2	33		A			
541–1	Ernest Carter	Brookover Well Drilling Co.	1963	460	6	127	21	120	Xsq	Apr. 1963	68	12	.16	D		8	270
3	Wilmer Steele	Walter Slauch	1932	390	6	94	60		Xsq					D	6.8	3	125
542–2	Rayner Darling			390					Xsq					P		7	250
543–1	Foster Jennings	Walter Slauch	1962	400	6	69	68	48, 69	Xsq	Sept. 1963	14	20	2.47	D	7.1	2	110
2	George Plymyer	I. N. Petersheim	1954	410	6	85	20		Xsq	Oct. 1954	23	14		D			
544–1	Mrs. Joseph Walker	C. L. Myers	1954	400	6	135	27		Xg	Nov. 1955	25	6		D			
2	C. Buckley	do.		355	6	48			Xwm		8			D		2	105
546–1	Brook Lee, Jr.			470					Xwm					D	5.3	2	65
2	James LaFrance	C. L. Myers	1954	505	6	200			Xwm	Nov. 1963	8	20		D	6.6	2	90
3	do.			495		100			Xwm			10		D			
548–1	Walter Wickes			500	6				pCbn	Oct. 1963	18			D	5.8	2	110
549–1	C. C. Brosius	C. L. Myers	1927	505	6	90	50		Xsq		60			D, S	6.0	10	410
550–1	Brinton and Lawrence Hood	I. N. Petersheim	1958	535	6	344	152		Xwm	1958	48	7		D, S	7.2	3	130
2	do.	C. L. Myers	1920	545	6	130			Xwm		30			D, S			
551–1	Robert Paxson	LeRoy Well Drilling Co.	1960	630	6	115	90	30, 60, 85–90, 110	Xwm	Aug. 1963	30	20	.12	D	6.6	2	70
552–1	H. H. Clark, Sr.	C. L. Myers	1958	550	6	58			Xwm	Aug. 1963	13			D	6.1	2	75
553–1	C. E. Guthrie	Sutton	1959	535		96			Xwm					D	6.0	2	70
2	Roland	Hope Womble	1960	545				50	Xwm		30			D			
554–1	George Curme			590	6				Xwm					D	6.4	4	165
555–1	George Maule			585		40			Xpc		19			D	5.6	3	105
556–1	William Bittle	Hope Womble	1958	600		101			Xpc					D			
2	Meade Shuman	C. L. Myers	1962	590		98			Xpc					D	6.2	2	65
557–1	Norman Laffey			455	6	32			Xpc	Aug. 1963	13			D	6.1	6	215
2	do.			460	6	52			Xpc	Aug. 1963	2		.92	S	5.1	3	90
558–1	Earl Egoff			520		42			Xpc	Aug. 1963	39	10		D	[illegible]	[illegible]	[illegible]

537-1	E. H. Harvey	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
538-1	Mrs. John Baker	Trego Bros.	1954	360		121	19		Xwm			3		D			
539-1	D. J. Torrens			350	6	160			Xwm	Oct. 1963	36	16		D	7.2	4	145
2	G. S. Moore	Thomas Keyes	1961	245	5	200	22	40, 180	Xwm	Dec. 1961	5	12		D			
540-1[a]	J. T. Crossland			370	36	25			Xwm	Aug. 1950	22			D			
2	Dela A. Brown			360	6	48			Xwm	Oct. 1963	26			D			
541-1	Harold Ryan		1955	415	6	140			Xwm	Oct. 1963	49	5		D	6.1	2	85
2	L. B. Steele	I. N. Petersheim	1954	300	6	76	22		Xwm	Oct. 1954	30	11		D	6.7	5	210
542-2	B. O. Smith	C. L. Myers		460	6	254			Xwm			12		P			
3	M. T. Brown	do.		405	6	181	30		Xwm		16			D	6.5	9	360
4	A. D. Loller	Thomas Keyes	1961	420	5	120	39	70, 90	Xwm	Oct. 1961	40	3		D			
5	Robert Brown	I. N. Petersheim	1954	410	6	80	24		Xwm		30	9		D	6.4	1	50
543-1	Unionville Elementary School	do.		460	6	230			Xwm			17		P			
2	P. M. Davidson	do.	1959	458	6	120	69	102, 112	Xwm	June 1959	17	8		D		2	100
3	Unionville High School	C. L. Myers	1958	440	6	300	100	30, 180	Xwm			72		P			
4	Unionville Elementary School		1930	470		400			Xwm	Oct. 1963	44	18	.09	P		2	140
5	Walter Herring	I. N. Petersheim	1958	420	6	79	43	33, 55, 70	Xwm	Oct. 1958	17	30+		D	6.3	1	72
6	John Hufford	do.	1955	485	6	121	38		Xwm	July 1955	37	12		D			
544-1	Haines Howard	C. L. Myers	1962	435	6	127	53		Xwm	Oct. 1962	15			D		4	230
2[a]	Mrs. J. B. Hannum			470	44	23			Xg	Nov. 1955	17			A			
3	Paul Sellers	C. L. Myers	1945	390		98	42		Xwm		30	15		P			
4	Ellis Mitchell	I. N. Petersheim	1959	415	6	213	69	150, 170, 200	Xwm	Oct. 1959	8	25		D		2	95
5	Paul Sellers	C. L. Myers	1940	420		100			Xwm		35			D, S		2	120
6	L. Pever	Robert Mattson	1963	410	6	101	60		Xwm	1963	20	11		D			
7	R. L. Cox	I. N. Petersheim	1957	410	6	90	60	30, 75	Xwm	Aug. 1957	5	10		D			
8	Anna M. Alexander	do.	1959	430	6	83	30	50, 70	Xwm	Sept. 1959	25	14		D			
9	E. W. Crosson	do.	1954	435	6	69	55		Xwm	Nov. 1954	35	25		D			
10	Mrs. Ruth Black	do.	1954	430	6	75	30		Xwm	Oct. 1954	35	8		D			
11	Charles Burnett	do.	1954	435	6	149	77		Xwm	Nov. 1954	18	10		D			
12	Cecil Jackson	do.	1958	440	6	95	56	25, 70, 85	Xwm	Oct. 1958	17	25+		D			
13	W. H. Jones	do.	1962	445	6	148	39	80, 140	Xwm	July 1964	7	20		D	7.6	3	120
545-1	Mrs. John Hannum	C. L. Myers	1962	530	6	80	43		Xwm	Sept. 1962	40	7		D			
2	H. C. Fair			455	6	88			Xwm	Oct. 1963	19			D	5.4	2	80
546-1	Miss Christine Hannum	Clifford Myers	1963	510	6	120	38	40	Xwm	Oct. 1963	34	12	.2	D	6.3		105
547-1	C. M. Kline		1957	490	6	90			pCbn	Oct. 1963	17			D	6.2	3	125
548-1[a]	J. E. Ryan			540	24	20			pCbn	Aug. 1950	13			O			
2	A. J. Nesbitt			510	6	45			pCbn	1960	10			D	5.8	4	210
550-1	Bennett Wertz	C. L. Myers	1949	520	6	176			Xwm	Oct. 1963	40			D	5.9	2	95
2	Howard Wertz			480	6	100			Xwm	Oct. 1963	26			A			
551-1	Mrs. J. B. Hannum	C. L. Myers	1962	575					Xwm					D	6.3	2	95
552-1	James Gill			560		90			Xwm					D	6.8	5	180
553-1	Buck and Doe Farm			490	6	54			Xwm	Aug. 1963	28			A			
2	do.	C. L. Myers	1963	490	6	77	31		Xpe	Oct. 1963	31	20+	6.69	D			
554-1	Ernest Pyle	Hope Womble	1957	580		81	44	62, 68, 73, 76, 81	Xpe	May 1957	22	15		D	7.2	5	210
2[a]	D. L. Gibbs			560	48	39	8		Xpe	Sept. 1951	36			A			
3	Harold Heidelbaugh	Walter Slauch	1930	560	6	58	48		Xpe	July 1964	9			D	6.0	2	75
555-1	Robert Benning	Hope Womble	1957	595	6	78	23	58, 63, 69, 78	Xpe	July 1957	30	9		D	7.6	6	210
2	R. L. Myers	C. L. Myers	1962	610	6	95	22		Xpe	June 1963	42	15		D	6.0	2	120
3	Chester McConnell	Hope Womble	1957	575	6	72	51		Xpe	June 1963	26		11.3	D	5.8	5	300
4	Paul Hastings	C. L. Myers	1963	580	6	82	63		Xpe	Sept. 1963	32	8		D			
556-1	J. C. McHenry			580	6	103			Xpe	Aug. 1963	47		.8	D	5.9	3	85
557-1	Ross McLimans			590		72	10		Xpe	Aug. 1963	37			D	5.8	2	50
558-1	R. W. Mendenhall			460	6	40			Xpe	Aug. 1963	23		6.27	D, S	5.6	4	170
954-533-1	Joseph Howarth	Burdick and Sadler	1951	425	6	50			pCbn	Nov. 1963	16			D	6.8	4	180
534-1	C. W. Davis, Jr.	Charles Mock	1963	445	7	116	17	22, 55, 99, 110–112	Xsq	Dec. 1963	50	16	.60	D	6.6	4	170

Table 5. Record of drilled wells—Continued

Well number	Owner	Driller	Date completed	Altitude above sea level (feet)	Diameter of casing (inches)	Total depth (feet)	Depth to bottom of casing (feet)	Depth to water-bearing zones (feet)	Aquifer	Static water level: Date measured	Static water level: Depth below land-surface (feet)	Reported yield (gpm)	One hour specific capacity (gpm/ft)	Use	Field analyses of water: pH	Field analyses of water: Hardness (gpg)	Field analyses of water: Specific conductance (micromhos at 25°C)
						Chester County—Continued											
954–534–2	M. R. Davis	I. N. Petersheim	1953	475	6	135	22		pCbn	1953	32	15		D			
3	C. W. Davis, Jr.	do.	1955	480	6	85	40		pCbn	Dec. 1963	40	20		D	5.7	3	210
535–1	J. R. Michelson	Burdick and Sadler	1954	290		85		30, 85	Xwm					D	6.0	2	100
536–1	George Steele	I. N. Petersheim	1958	230	6	65			Xwm	Dec. 1963	18			D	5.4	2	125
2	W. P. Worth	Well Drillers Inc.	1948	310	6	150	10		Xwm			25		D			
537–1	Stewart Ramsay			275	6	132			Xwm	Nov. 1963	37		.5	D	6.1	7	290
2	Radley Run, Inc.			250	6				Xwm					P	6.2	4	220
538–1	Pocopson Township	Thomas Keyes	1962	290	5	86	44		Xwm	May 1962	42	20	4.56	P		2	110
539–1	Pocopson Home	C. L. Myers	1947	147		201			Xwm	Dec. 1961	26		.27	P			
2	do.	do.		157		256			Xwm	Dec. 1961	34		.18	P			
3	A. W. Browning	Thomas Keyes	1963	380	6	150		36, 50, 72, 82, 95, 115	Xwm	July 1963	20	24		D	6.1	2	100
540–1	James Hutchinson	Trego Bros.	1958	410		112	12		Xwm	Oct. 1963	48	15		D	5.1	1	25
2	Mrs. Florence P. Battin	I. N. Petersheim	1952	385	6	73	53		Xwm	1952	30			D			
541–1	Hayman and Sons	do.	1953	385		120			Xs	Oct. 1963	30	20+	.6	D		5	230
542–1	W. H. Taylor			405		107			Xwm	Oct. 1963	29			D		2	140
543–1	W. C. Latham	William Crosson	1963	485	6	83	15		Xs	Oct. 1963	50	15		D	7.4	15	150
2	Clyde Latham	do.	1963	465	6	92	65		Xwm	Oct. 1963	33	30		D	6.2	9	350
3	Richard Herring	I. N. Petersheim		450	6	231	56	70, 210	Xwm		50	6		D			
544–1	Mrs. Katherine Rickabaugh	C. L. Myers	1954	510	6	164			Xwm	Oct. 1963	27			D, S	6.2	4	170
545–1	Edgar Scott, Jr.	Thomas Keyes		390	6	200	22	27, 61	Xwm		18	3		A		4	190
2	Mrs. John C. Hannun	I. N. Petersheim	1957	535	6	213	34	120	Xwm	Nov. 1957	45	7		D	6.4	25	1,150
546–1	do.	Clifford Myers	1962	455	6	170	40		Xwm	May 1963	48	0		A			
2	do.	do.	1962	410	6	110			Xwm			8		D	7.3	16	550
3	Mrs. John Cheshire	Walter Slauch	1959	345	6	77	32		Xc	Sept. 1963	28	20	1.12	D	7.8	5	170
547–1	Mrs. Josiah Swett	I. N. Petersheim	1962	365	6	392	45	200	Xc	Nov. 1962	40	3		D	7.2	4	180
2	Mrs. Mary Ramsey	do.	1960	390	6	350	52	335	Xwm	Sept. 1963	67		.15	D, S	6.7	3	110
548–1	A. P. Reynolds		1940	325	6	135			Xsq	Jan. 1960	98			D, S	7.1	8	260
2	Buck and Doe Farm			340	10	67			Xc	Sept. 1963	52			D	6.8	5	150
3	do.			300	6	33			Xc	Aug. 1951	15		78.5	O		8	310
549–1	J. R. H. Thouron	Thomas Keyes	1962	335	6	52	26	22, 40	Xwm	Mar. 1962	20	20		D	6.1	6	270
2	do.	Sutton	1959	350	6	147	54		Xwm	1959	38	22		D, S	6.5	3	120
3	do.			320	6	86	34		Xwm	Oct. 1963	8			D	6.2	4	165
550–1	Buck and Doe Farm			370					Xc					D	6.8	9	310
551–1	Robert Crompton			400	6				Xwm	Aug. 1963	40			D	6.5	2	85
552–1	G. C. Lucas	Robert Mattson	1960	555	6	117	60		Xpc	Aug. 1963	67	15	1.24	D	6.0	1	59
2	Robert Crompton	Thomas Keyes	1963	430	6	97	38	15, 40, 76, 86	Xpc	July 1963	7	20		S			
553–1	Donald Fredd			560	6	81			Xpc	Aug. 1963	64	3		D	6.0	1	50
554–1	Elmer Beiler	I. N. Petersheim	1963	595	6	210	112	125, 210	Xpc	Aug. 1963	33	15	.12	D	6.7	5	170
2	George Freeman	C. L. Myers	1963	585	6	80	29		Xpc	Nov. 1963	40	8		D, S	4.8	3	125
555–1	Norman Smoker	I. N. Petersheim	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]		D	6.6	6	105

2	do.	do.	1962	510	6	170	18		Xwc	June 1963	8	½	.04	A	7.6	5	210
955–532–2	Mrs. E. Manganaro	Thomas Keyes	1962	375	6	175		142, 166	pCbn	Dec. 1962	80	15		D			
3	Jack Copeland	do.	1962	280	6	82	42	39, 44, 58	pCbn	Oct. 1962	18	15+		D	6.6	2	75
533–1	Paul Hoell			360		253			pCbn					D	6.4	4	190
2	C. L. Twadell		1963	400	6	135	28	85	pCbn	Nov. 1963	80		1.27	D	6.1	5	280
3	Marshall Jones	Thomas Keyes	1963	260	5	100	26	35	pCbn	June 1963	8	2		D	6.4	3	105
534–1	Raymond Velde	Burdick and Sadler	1954	345		54			pCbn					D	5.9	3	160
2	Westtown Water Co.	Thomas Keyes	1963	350	6	76	35	7, 44	pCbn	April 1963	3	45		P	5.8	2	125
3	J. C. Burdick	J. C. Burdick	1952	355	6	68	36	30	Xwm	1952	18	8		D	5.8	3	150
4	do.	do.	1954	325	12	88	20		Xwm	1954	29	18		D			
5	Hibbard Bartram	Thomas Keyes	1963	375	6	160	52	85, 105–130	Xwm	Sept. 1963	35	4		D	6.9	7	280
535–1	James McCormick	do.	1962	345	6	221		100	Xwm	May 1962	10	2		D	7.0	5	170
2	William Tamburro	do.	1962	325	5	180	44	90, 167	Xwm	July 1962	20	5		D			
536–1	J. J. Sullivan III			270	6				Xwm					D			
537–1	Earl Young	Thomas Keyes	1962	295	5	120	24	68, 95, 110	Xwm	Sept. 1962	35	5		D			
539–1	H. W. Lord	Brookover Drilling Co.	1963	240	6	55	23		Xg	Oct. 1963	37	9	.65	D	6.4	5	210
2	Earl Sykes	do.	1964	250	6	85			Xg	Feb. 1964	16	14		D			
540–1	Charles Benzel, Jr.	Thomas Keyes	1959	300	6	320	38	48, 130, 300–320	pCbn	Oct. 1963	43	7	.2	D	6.6	4	180
541–1	F. Dean			200		98			pCbn	Oct. 1963	16			D		7	300
542–1	M. J. McClure			205		80			Xwm		15			D		2	65
2	Deery	I. N. Petersheim	1955	355	6	70	16		Xwm	June 1955	45	10		D			
543–1	William Byerly	C. L. Myers	1949	230		109			Xwm		2			D		3	200
544–1	Robert Flamer	do.	1954	340		176			Xpc	1954	38	4		D	6.4	3	85
546–1	G. B. Hilton	McCorkle		520		114			Xwm					D			
549–1	Buck and Doe Farm	C. L. Myers	1962	340	6	95	80		Xc	Oct. 1962	20			D, S	7.2	11	380
550–1	M. P. Mackey-Smith		1937	505	10	180			Xwm					D	5.8	5	185
551–1	Dallett Johnson	C. L. Myers	1939	450	6	100			Xwm	Aug. 1963	33		7.58	D	6.3	2	58
552–1	Arthur Matthews			465	6	100			Xpc	Aug. 1963	20			D	5.8	3	120
553–1	Andrew Lemhenny	Hope Womble	1953	560	6	80	40		Xpc		30		5.0	D	5.7	1	45
554–1	J. M. Supplee		1920	580		50	8	28, 45	Xpc					D	6.1	3	110
2	Clyde Hess	Walter Slauch	1930	620	6	426			Xpc			0		A			
556–1	Octarara Junior-Senior High School	C. L. Myers	1954	685					Xwc			10		A			
2	do.	do.	1954	675		300		100	Xwc			35		P	6.1	8	300
3	Octarara Elementary School	I. N. Petersheim	1962	690		400		80	Xwc	1962	40	3		A			
4	do.	do.	1962	660		200			Xwc			3		A			
556–5	Annie S. Blank	C. L. Myers	1955	615	6	45	20		Xpc	Sept. 1963	14		3.40	D, S	5.8	3	120
6	Octarara Elementary School	I. N. Petersheim	1964	675	6	190	41	45, 135	Xwc	Jan. 1964	30	18		P			
7	C. H. Brosius	do.	1954	660	6	107	25		Xwc	Nov. 1954	40	18		D			
8	C. L. Behrendt	do.	1956	605	6	74	19		Xwc	Sept. 1964	43	20+	14.6	D	6.0	4	150
557–1	Ormar Umble		1920	640	6	300			Xpc	Aug. 1963	43		.05	S	6.1	8	475
558–1	Lawrence Ritter	I. N. Petersheim	1928	625	6	60	40		Xwc		10	30		D	5.7	2	90
559–1	L. H. Schoff			645	6				Xwc					D, S	5.5	4	145
956–531–2	Warren Blair	Burdick and Sadler	1952	310		80			pCbn			12		D		3	140
532–1	Westtown School	Thomas Keyes	1962	310	12	255	84	80–85, 120, 182, 224	Xwm	Feb. 1962	15	350	8.42	P			
2	Russell Jones	do.	1963	300	5	160	32	50, 130	Xwm	June 1964	13	15		D	6.8	4	170
3	do.	do.		285		125		70	Xwm			1		A			
4	do.	do.		260		80			Xwm			0		A			
533–1	Westtown Water Co.	do.	1962	375	12	126	30		pCbn	May 1963	10	165	4.2	P			
2	Westtown Elementary School	Artesian Well Drilling Co.	1952	285	6	300			Xwm					P		4	130
3	Donald Graham	Thomas Keyes	1962	290	5	120	39	65, 85	Xwm	June 1962	50	4	.06	D	6.9	4	165
4	Robert Dietshe	do.	1962	345	5	100	23	65, 73	pCbn	June 1962	60	8		D	6.5	3	115
5	Charles Boyd	do.	1962	320	5	100	33	60, 80, 93	pCbn	Sept. 1962	45	15		D			
6	Robert Garrett	do.	1961	330	5	80	40	60, 70	pCbn	Dec. 1961	35	12		D			

Table 5. Record of drilled wells—Continued

Well number	Owner	Driller	Date completed	Altitude above sea level (feet)	Diameter of casing (inches)	Total depth (feet)	Depth to bottom of casing (feet)	Depth to water-bearing zones (feet)	Aquifer	Static water level: Date measured	Static water level: Depth below land-surface (feet)	Reported yield (gpm)	One hour specific capacity (gpm/ft)	Use	Field analyses of water: pH	Field analyses of water: Hardness (gpg)	Field analyses of water: Specific conductance (micromhos at 25°C)
							Chester County—Continued										
956-533-7	William Wood	Thomas Keyes	1962	290	5	90	62	20, 40, 80	pCbn	Feb. 1962	8	50		D	6.5	3	115
534-1	W. D. Griffin	do.	1963	425	5	63	35	36, 40, 48	pCbn	Nov. 1963	32	20		D	6.2	2	85
2	Daniel Goodwin	do.	1963	415	5	100	60	70, 75, 85	pCbn	May 1963	25	10		D	6.1	2	85
535-1	James Lenhart		1954	440		125			pCbn					P			
2	Frank Guisuppi	Thomas Keyes	1962	435	6	240	62	26, 57, 63	pCbgb	Oct. 1962	30	2		D	6.7	3	110
3	Joseph Ferrer	do.	1963	450	6	130		77	pCbgb	Oct. 1963	35	1/4		D			
4	George Hare	do.	1963	460	6	75	27	54, 56	pCbgb	Sept. 1963	40	7		D			
5	Frank Girraffe	do.	1963	410	5	71			Xg	July 1963	27	7		D	6.5	5	200
6	James John	do.	1963	410	5	120	50	60	Xg	April 1963	30	4		D			
7	R. L. Black	I. N. Petersheim		410	5	41	30		Xg		25	20		D			
8	George Williams	do.	1953	405	6	52	43		Xg	Aug. 1953	15	4		D			
536-1	Eachus Dairies Inc.		1930	390		165			pCbgb					I			
2	Book Barn and Country Store Museum		1947	325	6	70	20	35–40	pCbgb	Dec. 1963	21	25	.76	D	6.4	5	240
3	C. DeFelice	Thomas Keyes	1964	355	5	188	26	10, 37–41	pCbgb	April 1964	10	75+	8.39	P	6.9	3	130
4	do.	do.	1964	360		130	40		pCbgb	April 1964	30	25		A			
537-1	West End Gun Club	do.	1962	235	5	95	26	87	Xg	July 1962	12	30		P		6	220
2	Eugene Buglio			390	6	87			pCbgb	April 1963	22	5		D	6.2	4	185
3	Raymond Fink	Thomas Keyes	1963	420	5	90	20	35	pCbgb	Aug. 1963	25	4		D	6.7	7	260
538-1[a]	Mrs. Margaret Moore			360	48	45			pCbgb	Oct. 1963	43			D	6.2	6	270
2	J. J. Gerlach	C. L. Myers	1953	370	6	195	20		pCbgb	1953	30	5		D	7.2	7	290
539-1	Stephen Barry, Jr.		1958	315		90			Xg	1958	60	30		D	6.1	4	160
540-1	C. N. Tanguy	I. N. Petersheim	1940	390	6	92	40	35–40, 85	Xwm	Oct. 1963	52	7		D	6.0	6	250
541-1	W. W. Moreland	Trego Bros.	1963	260	6	78	43		Xwm	Oct. 1963	40	14	2.21	D	6.0	2	75
542-1	Stanley Scofield	C. L. Myers	1945	370	6	228	50		Xwm	Oct. 1963	53	3		D	6.0	5	230
543-1[a]	E. S. Barr			360	24	18	7		Xpc	April 1951	14			D			
2	Embreeville State Hospital			290	8	166			Xpc	Sept. 1956	2	24		A			
3	do.			300	8	246			Xpc	Sept. 1956	12	5		A			
4	do.			410	8	145			Xpc	Sept. 1956	10	15	.39	A	5.4	4	
5	do.			350	6	188			Xpc	Sept. 1956	29	13		A			
6	do.	F. H. Bollinger and Sons		215	14	170	64		Xwm	Sept. 1956	7	270		P			
7	do.	do.	1956	205	14	170	51		Xc	Nov. 1956	3	330	5.2	P		8	310
544-1	Raymond Lied	C. L. Myers	1962	415	6	68	14		Xpc	Aug. 1962	33			D	6.1	4	160
2	Herbert Bickings	I. N. Petersheim	1953	295	6	67	30		Xpc	Oct. 1953	6	6		D	5.9	5	165
3	Norman Charlton	do.	1955	255	6	67	34		Xpc	Dec. 1955	6	12		D			
545-1	Harry Young			300	6	54			Xpc	Sept. 1963	20			D	7.1	8	265
546-1	Thomas Cummings	Herbert Hornberger	1959	330	6	88		78	Xpc	Aug. 1963	27	12	.6	D	7.0	4	160
547-1	Howard Steen	I. N. Petersheim	1957	410	6	255	25	70	Trd	Mar. 1957	52	1/2		D	7.3	5	175
548-1	Mary Belle Ramsay			550		100+			Xpc					D	6.0	4	135
2	Brandywine Area School Board			520	6	334	200		Xpc			8		P			
3	Buck and Doe Farm	Clifford Myers	1963	340	6	60	7		Xpc	Sept. 1963	3	40		D	6.2	3	140
[illegible]	[illegible]	do.	1956	450	6	65	46	65	Xwm	Aug. 1956	32			D	7.2	3	110

553-1	Rawlins McGuigan	Robert Mattson	1963	[illegible]	6	175	44		Xwc	Aug. 1963	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
2	O. D. McAdams	C. L. Myers	1960	500	6	100	6		Xpc	Aug. 1963	21		6.31	D	6.3	2	58
3	Rawlins McGuigan	Robert Mattson	1963	600	6	110	25	65, 70, 110	Xwc	Aug. 1963	25	80		D			
4	do.	do.	1964	610	5	100	30	37, 55, 70, 80–100	Xwc			30		P	6.4	2	70
5	do.	do.	1964	660		140			Xwc			0		A			
554-1	B. S. Lantz		1949	640	6	94			Xpc	Aug. 1963	46		1.62	D	6.0	4	215
2	William Petrohey		1940	675		105			Xwc	Aug. 1963	23			D	5.8	3	200
555-1	J. S. Herr	I. N. Petersheim	1954	655	6	80	32		Xwc	Aug. 1963	49	20+	9	O	5.6	3	180
2	do.	Walter Slauch	1930	655	6	104	15		Xwc	July 1963	35		5.3	D, S	5.6	3	130
3	L. S. Reid		1930	665		75			Xwc		25			D, S	5.4	3	145
4	R. P. Guiney	C. L. Myers	1963	595	6	150	84	20, 40–60, 100–110	Xwc	Sept. 1963	12	10		D, S			
556-2	Harold Stoltzfus	do.	1963	590	6	98	22	50	Xwc	July 1963	35		4.55	D, S	5.8	3	180
3	Edith Griest	do.	1963	620	6	67	20	42, 52	Xwc	Aug. 1963	19	55	38.2	D, S	6.2	3	120
557-1	W. R. Burns	I. N. Petersheim	1954	640	6	70	20		Xwc	Oct. 1954	10	25+		D	6.3	4	260
2	Vernon Kennel	do.	1952	515	6	160	30		Oc	Mar. 1952	30	10+		D	7.6	12	430
558-1[a]	N. P. Buckwalter		1809	500	36	17			Xwc	July 1963	12			D, S	5.8	3	110
2	N. P. Buckwalter, Sr.			460		43			Oc					D	6.3	5	220
3	A. H. Harvey Estate	C. L. Myers	1963	600	6	100	85	75–80	Xwc	Sept. 1964	25	13	.78	D, S	5.9	2	65
957-530-1	D. Frysinger			340	6	95	65	3 zones	pCbn		6			D		6	280
2	Hunters Run Apartments	Thomas Keyes	1963	355	6	310	108	58, 107, 154	Xs	May 1963	20	80		P	7.0	5	180
3		John Turk	1963	365		125	69		pCbn			14					
531-1	James Lees	Thomas Keyes	1963	360	6	82	52	40, 56	Xwm	Jan. 1963	20	30	.94	D		2	80
2	F. C. Dreyer	Artesian Well Drilling Co.	1956	470	6	76	56		pCbn			5		D		2	60
3	McKilty	Artesian Well Drilling Co.	1956	480	6	71	21		pCbn	May 1956	30	8		D		3	100
4	Pollizzotti	do.	1956	450	6	89	28		pCbn	May 1956	28	9		D		4	175
5	Richard Shoemaker	Thomas Keyes	1957	475		150			pCbn					D		8	460
6	J. A. Murrison	do.	1962	490	6	68		52	pCbn	Jan. 1962	30	10		D	6.6	3	120
7	Arthur Binns	do.	1963	355	6	389	37	35, 43, 140, 155, 246, 252, 285	Xwm	May 1963	30	30		D			
8	G. E. Kearns	do.	1963	340	5	100	20	24–26, 31–34	Xwm	Oct. 1963	18	8	2.37	D	7.3	3	140
9	Westtown Water Co.	do.		340		300	75		pCbn		7	270		P			
532-1	Frank Troilo	do.	1963	310	6	102	24	40, 44, 62, 73, 96	pCbn	Apr. 1963	20	14	.54	D			
2	Charles Robinson	do.	1963	340	6	122	21	40, 94, 115	Xwm	Jan. 1963	40	30+	.70	D			
3	James Lees	do.	1963	295	6	115	25		pCbn	May 1963	17	15		D			
4	R. J. Love	John Turk	1959	460	6	200	13	60	Xg	Summer 1963	100	5		D	6.4	6	270
5	Borough of West Chester		Before 1930	350	8	50			pCbn	Apr. 1951	13	100		A			
6	Horace Cornog	Thomas Keyes	1961	360	5	60	28	35, 39, 47	pCbgb	Sept. 1961	35	20		D	6.5	4	160
7	T. V. Bates	do.	1961	360	5	60	43	5, 53	pCbgb	Nov. 1961	38	20		D	6.5	4	135
8	P. H. Egolf, Jr.	do.	1962	480	5	158	21	78	pCbgb	Jan. 1962	45	¾		D	6.5		210
9	Leon Schultz	do.	1963	425	5	100			Xg	April 1963	48	5		D	6.5	6	200
10	J. H. Baldwin	do.	1961	365	5	80	59	20, 43, 70	pCbgb	Nov. 1961	5	12		D	6.8	2	80
533-1	G. P. Warren, Jr.	do.	1963	330	5	60	29	26, 45	Xg	Aug. 1963	5	75		D	6.7	4	135
534-1	Blanche Lamborn	Thomas Keyes	1963	385	12	140	87	105, 125	Xg	Mar. 1963	10	10		D			
2	Norman Walck	do.	1963	415	5	77	25	32, 36, 55	Xg	June 1964	6	12		D	6.7	3	125
3	A. H. Medwing	do.	1962	385	5	80	55	41, 70	Xg	Aug. 1962	8	8		D			
4	Louis DiStefano	do.	1962	440	5	100	46	61	pCbgb	Dec. 1962	20	6		D	7.4	6	245
5	Optimists Little League of West Chester, Inc.	LeRoy Myers	1964	445	6	53	52		pCbgb	May 1964	10	25		P			

Table 5. Record of drilled wells—Continued

Well number	Owner	Driller	Date completed	Altitude above sea level (feet)	Diameter of casing (inches)	Total depth (feet)	Depth to bottom of casing (feet)	Depth to water-bearing zones (feet)	Aquifer	Static water level: Date measured	Static water level: Depth below land-surface (feet)	Reported yield (gpm)	One hour specific capacity (gpm/ft)	Use	Field analyses of water: pH	Field analyses of water: Hardness (gpg)	Field analyses of water: Specific conductance (micromhos at 25°C)
Chester County—Continued																	
957–535–1	Brandywine Mushroom Co.		1920's	405	6	114			Xg		25	85		I			
2	do.	C. L. Myers	1948	405	6	235			Xg	1948	15	35		I			
3	do.	Thomas Keyes	1961	400	8	107	49		Xg	Sept. 1961	23	100		I			
4	Wyeth Laboratories	do.		407	6	200	66		Xg			14		I			
5	do.	do.	1963	402	6	230	41	60, 85, 175	Xg	Nov. 1963	6	60		I			
536–1	C. E. Travis, Sr.	do.	1963	385	5	150	19	30, 130	pCbgb	Aug. 1963	25	4		D	6.4	8	320
537–1	John Pennypacker	DiRocco	1957	400		73			pCbgb					D		6	310
538–1	Willis Yearsley	Brookover Well Drilling Co.	1963	300		106	14	100	pCbgb			13		D	7.2	6	230
539–1[a]	T. P. Harney			240	30	38			pCbn	July 1951	37			A			
2	R. M. Armstrong	Brookover Well Drilling Co.	1963	200	6	90			Xwm	Nov. 1963	12			D	6.2	5	240
3	T. P. Harney		1933	250	6				pCbn	1933	35			D	6.4	6	280
540–1	Marshallton Farms Inc.	Brookover Well Drilling Co.	1963	400	6	85	26	34, 67	Xwm	Mar. 1963	35	12	.08	D			
2	do.	do.	1963	430	6	110	33		Xwm	Apr. 1963	44	12	.1	D		3	120
3	do.	do.	1963	430	6	97	27	70–85	Xwm	Apr. 1963	45	10		D			
4	do.	do.	1963	425	6	134	29		Xwm	Apr. 1963	48	3		D			
5	Marshallton Farms Inc.	Brookover Well Drilling Co.	1963	420	6	90	14		Xwm	Apr. 1963	45	5		D			
6	do.	do.	1963	425	6	178			Xwm			1		A			
7	do.	do.	1963	425	6	92			Xwm	April 1963	55	14		D			
8	do.	do.	1963	430	6	91			Xwm	April 1963	39			D			
9	do.	do.	1963	430	6	91			Xwm	April 1963	42		.2	D			
10	Graydon Whitney	Burdick and Sadler	1950	285	6	150	20	140–145	Xc	Nov. 1963	29	3	.1	D	7.3	5	180
541–1	Robert Hodge	Trego Bros.	1961	465	6	167	40	160	Xpc	Nov. 1963	39	6	.1	D	5.7	2	105
2	do.	C. L. Myers	1957	450	6	164	45		Xwm	Nov. 1963	32	8	3.78	D	5.6	3	150
3	do.	do.		450	6	100			Xpc	Nov. 1963	39	1		A			
542–1	G. H. Williams	do.	1962	415	6	108	24		Xpc	May 1962	37			D	6.8	2	100
2	D. L. Hungerford	do.	1962	405	6	95	23		Xpc			14		D	5.9	3	90
3	George Haigh	LeRoy Myers	1962	445	6	170	22		Xpc	Dec. 1962	44	3		D			
4	Kenneth Geary	C. L. Myers	1962	350	6	72	22		Xpc	June 1962	28	8		D	5.8	3	100
5	Louis Baker	do.	1962	360	6	104	27		Xpc	July 1962	33			D	6.5	4	150
543–1	C. E. Woolford	Herbert Hornberger	1962	450		320		250	Xpc			20		D	6.3	3	105
544–1	G. H. Supplee	C. L. Myers	1961	425		111			Xwc	Oct. 1963	38	8	.1	D	5.3	3	110
2	Frank Carson	I. N. Petersheim	1963	475	6	130	24		Xwc	Sept. 1963	26	6		D	6.9	4	170
545–1	Harvey Williams, Jr.	Herbert Hornberger	1959	400		60			Xwc	Aug. 1963	20		3.51	D	6.0	3	130
546–1	Theodore Leofsky			350		35			Xwc		5			D	6.1	3	115
547–1	Carlin Bros.	Clifford Myers	1962	450	6	65	21		Xpc	Spring 1962	25	11		D	6.2	6	250
2	do.	do.	1963	440	6	150	23		Xpc	Oct. 1963	27	6	.04	D	6.6	6	285
3	Carlin Bros.	Clifford Myers	1964	430	6	63	22		Xpc	Apr. 1964	11	20+		D			
548–1	Frank Broomell	do.	1962	300	6	104	36		Xpc	Apr. 1962	30			D	6.5	5	190
2	Ernest Reeder	C. L. Myers		350	6	90	40		Xpc	Summer 1961	20			D			
[illegible]	[illegible]	C. L. Myers	1958	425	6	65			Xpc	1958	Flowing			D			

550-1	Jesse Diffenderfer	C. L. Myers	1962	545	6	77	26		Xwc	Nov. 1962	30			S	6.0	7	280
2	F. W. Montgomery	Hope Womble	1959	535	6	70	15		Xwc	Aug. 1963	28	20	3.29	D	6.0	2	75
3	Brandywine Area School Board	C. L. Myers		555	8	200	44		Xpc			312		P	5.9	3	100
551-1	Mrs. J. I. Copeland	do.	1962	625	6	300	23		Xwc			0		A			
552-1	Donald Bachman	C. L. Myers	1962	550	6	151	56		Xwc	Oct. 1962	66		3.68	D	5.9	2	90
553-1	G. H. Conley	Robert Mattson	1959	455	6	131	69		Oc	Summer 1959	18			D	7.2	18	640
2	Ralph Garris	do.	1960	480	6	67	60	60	Oc			16		D	7.1	16	570
3	Raymond Devlin	C. L. Myers	1963	495	6	50	42		Oc	Sept. 1963	26			D			
554-1	J. T. Morrison Estate	do.	1930	520	6	120			Oc	July 1963	22			D	7.0	15	500
2	Louis Boddy	Robert Mattson	1962	525		178	150		Xwc	Aug. 1962	48			D	7.1	2	75
555-1	William Benton	C. L. Myers	1963	550	6	74	18		Oc	Mar. 1963	16	20		D			
2	Carl Trommler	do.	1963	550	6	146	134		Oc	June 1963	28	20	.12	D	7.0	1	110
3	R. W. Burns	do.	1963	560	6	62	25		Oc	May 1963	40			D			
556-1	Harold Boyden			730		170			Ch					D	5.6	2	55
2	J. R. Rice, Sr.	Bailey	1955	620		105	60		Chp	Summer 1955	44	12		D	5.7	1	25
557-1	W. S. Smoker			610	6	35			pCbn	July 1963	16			D	6.2	2	75
2	N. W. Miller, Jr.			720	6				Cc	July 1963	38			D	5.6	1	50
3	Borough of Atglen		1920	570	6	65			pCbn		12	25		P			
4	do.	I. N. Petersheim	1960	615	6	359	40	40, 350	pCbn	July 1960	35	80		P			
558-1	Rare Metals Products Co.	C. L. Myers	1947	575	8	160			Chp	Aug. 1963	43	23	1.72	I			
2[a]	Ira Kennel			550		11			pCbn	July 1963	4			D, S	5.8	5	200
559-1[a]	David Smoker			495					pCbn			28		D	5.9	7	310
2	J. F. Baynard	C. L. Myers	1962	580	6	56			pCbn	July 1963	50		4.33	D	5.8	2	90
958-530-1	E. Fairbairn	Thomas Keyes	1959	380		180	34	110–150	pCbgb			2		D	6.7	2	
2	William Cavin	C. L. Myers	1951	460	6	150			Xg					D		5	260
3	W. B. Wilson	John Turk	1954	360		70			pCbgb					D			
531-1	do.		1960	415	6	230			pCbgb	Dec. 1963	44			D	6.6	6	270
2	do.			405		265			pCbgb					I			
3	do.		1953	395	6	80			pCbgb					I			
4	Bovan Land Development Co.	Thomas Keyes	1963	390	5	85	44	10, 35, 45	pCbgb	Sept. 1963	6	40		D		7	340
5	Edward Hollenbeck	do.	1962	425	6	204	49	53, 115, 150	Xg	Apr. 1962	17	4		I	6.5	8	220
6	Grant Benham	do.	1962	470	6	120	23	50, 69	pCbgb	July 1962	45	3		D			
7	do.	do.	1962	465	6	223	38	56	pCbgb	July 1962	21	1		D			
8	do.	do.	1962	455	6	145	21	138	pCbgb	July 1962	28	8		D			
9	do.	do.	1962	450	6	115	29	53, 75, 98, 112	pCbgb	May 1962	30	15		D			
10	do.	do.	1962	430	6	110	48		pCbgb	July 1962	25	5		D			
11	do.	do.	1962	420	6	58	35	38, 50, 55	pCbgb	Aug. 1962	20	30		D			
12	do.	do.	1962	405	6	93	80		pCbgb	Sept. 1962	10	24+		D			
13	do.	do.	1962	395	6	72	67		pCbgb	Sept. 1962	10	24+		D			
14	do.	do.	1962	400	6	100	34	18, 41, 55, 65, 83	pCbgb	Oct. 1962	6	5		D			
15	do.	do.	1962	405	6	52	29	25, 35	pCbgb	Sept. 1962	15	30+		D			
16	do.	do.	1962	410	6	200	34	34	pCbgb	Oct. 1962	10	4		D			
17	do.	do.	1962	420	6	100	34	41	pCbgb	Oct. 1962	10	6		D			
18	do.	do.	1962	420	6	70	26	32, 60	pCbgb	Sept. 1962	20	30		D			
19	do.	do.	1962	410	6	160	49	34, 48, 54	pCbgb	Sept. 1962	23	2		D			
20	do.	do.	1962	400	6	100	18	26, 97	pCbgb	Nov. 1962	20	5		D			
21	do.	do.	1962	380	6	120	26	32, 68	pCbgb	Dec. 1962	20	3		D			
22	do.	do.	1962	385	6	80	18	32	pCbgb	Nov. 1962	20	5		D			
23	do.	do.	1962	385	6	90	16	85	pCbgb	Nov. 1962	5	5		D			
24	do.	do.	1962	390	6	52	26		pCbgb	Nov. 1962	3	19		D			
25	do.	do.	1962	385	6	55	46		pCbgb	Sept. 1962	3	24		D			
26	do.	do.	1962	385	6	60	39	55	pCbgb	Oct. 1962	5	10		D			
27	do.	do.	1962	395	6	69	47		pCbgb	Oct. 1962	5	20+		D			

Table 5. Record of drilled wells—Continued

Well number	Owner	Driller	Date completed	Altitude above sea level (feet)	Diameter of casing (inches)	Total depth (feet)	Depth to bottom of casing (feet)	Depth to water-bearing zones (feet)	Aquifer	Static water level: Date measured	Static water level: Depth below land-surface (feet)	Reported yield (gpm)	One hour specific capacity (gpm/ft)	Use	Field analyses of water: pH	Field analyses of water: Hardness (gpg)	Field analyses of water: Specific conductance (micromhos at 25°C)
						Chester County—Continued											
958–531–28	Grant Benham	Thomas Keyes	1962	410	6	45	39		pCbgb	Sept. 1962	5	20+		D			
29	do.	do.	1962	425	6	60	27	17–55	pCbgb	Sept. 1962	20	40+		D			
30	do.	do.	1962	440	6	52	32	33–40	pCbgb	Sept. 1962	25	20+		D			
31	do.	do.	1962	415	6	115	55		pCbgb	July 1962	25	5		D			
32	do.	do.	1962	430	6	80	46	58, 72	pCbgb	July 1962	18	8½		D			
33	do.	do.	1962	435	6	70	38	39, 50, 59, 63	pCbgb	July 1962	20	10		D			
34	do.	do.	1962	445	6	90	30	50	pCbgb	Aug. 1962	30	6		D			
35	do.	do.	1962	470	6	130	28	40, 120	pCbgb	Aug. 1962	30	4		D			
36	do.	do.	1962	460	6	200	25	190	pCbgb	Aug. 1962	60	2½		D			
37	do.	do.	1962	455	6	225	15	40, 120	pCbgb	Aug. 1962	63	1		D			
38	Westtown Water Co.	do.	1964	378	5	140	47		pCbgb	July 1964	5	50		P			
39	do.	do.	1964	382	5	155	53		pCbgb	July 1964	5	100	6.92	P			
532–1	William Titter			470		80	36		pCbgb					D	6.5	3	130
2	do.	Thomas Keyes	1963	475	5	80	36	39–41	pCbgb	May 1963	20	8		D	6.8	2	120
3	James McEwen	do.	1963	475	5	70	44		pCbgb	Sept. 1963	31	20		D	6.6	6	165
6	Water View Farms	do.	1963	360	5	60	20	23, 30, 39	pCbgb	June 1963	3	15		P	6.6	4	150
7	do.	do.	1964	375	6	80	25		pCbgb			10		P			
8	do.	do.	1964	340	6	118			pCbgb	July 1964	3	18	.36	P			
533–1	R. Spenser	Thomas Keyes	1961	405	6	120	57	40, 64, 84, 87	Xg	Sept. 1961	20	4		D			
2	Geo. Pfahler	do.		410		94	54		pCbgb		18	8		D	6.0	3	180
3	N. E. Norris	do.	1962	405		100	35		pCbgb	Oct. 1962	14	8		D			
4	C. E. Bishop	do.	1953	360		68	7		pCbgb					D	6.2	2	130
5	Donald Rick	Gaster Drilling Co.		430	6	85	50		pCbgb					D			
536–1	Wilford Black		1951	315		40			Xs					P	6.4	9	360
537–1	Ray Facciolla	Thomas Keyes	1963	365	5	100	47	55	Xwm	Mar. 1963	35	8		D		3	120
2	American Legion	do.	1962	455	6	242	21	54, 192	Xwm	May 1962	42	30		P	6.6	4	165
3	Mrs. R. G. Park	do.	1963	460	6	138	47	25, 36, 49, 63, 72, 110, 125	Xwm	Apr. 1962	20	20		D	6.2	2	90
538–1	John Strickland			450	6	152			Xwm	Nov. 1963	47	15	1.99	D	5.6	3	160
2	George Frank	Thomas Keyes	1963	280	5	103	42	50, 65	pCbn	Dec. 1963	6	10		D	6.8	4	180
3	Albert DiPaolantonio	I. N. Petersheim	1964	355	6	200	36	40, 65	pCbn	June 1963	25	5		D	6.4	6	265
539–1	George Sweeney	Sadler	1951	480	6	100			Xwm	Nov. 1963	42			D	6.3	2	75
2	Wilmer Sibley	Thomas Keyes	1962	405	5	150	19	60, 85, 115	Xwm	June 1962	43	8		D	6.3	3	135
540–1	Allen Osborn	C. L. Myers	1963	290	6	158	15	90–100	Xpc	Apr. 1963	50	17		D	7.1	3	90
2	J. C. Hamilton	do.	1962	245	6	105	14		Xwm	Spring 1962	30	20		D		4	120
541–1	Robert Crawford	do.	1956	250	6	90			Xpc					D	6.2	2	70
2	do.	[illegible]	[illegible]	320	6	110	32		Xpc	Nov. 1962	37		[illegible]	D	6.5	2	95

543-1	Mrs. Maude Koons	Robert McCorkle	1952	595	6	110		49, +	Xwc	Oct. 1963	46		1.61	D	5.4	2	60
544-1	P. G. Book		1920	570	6	75			Xwc	Oct. 1963	61		2.2	D	5.5	3	130
545-1	Richard Gabriel	C. L. Myers	1962	465	6	92	22		Xwc	Dec. 1963	53	6		D	6.5	2	55
2	A. W. Coldren	I. N. Petersheim	1955	570	6	135	22		Xwc	June 1955	45	2		D	6.6	3	80
546-1	William Harris	Thomas Keyes	1962	590	6	390	21	38	Xwc	Oct. 1962	31	½		D	6.5	6	130
2	do.	Hope Womble	1957	590	6	211			Xwc			0		A			
547-1	V. F. Vietri	C. L. Myers	1962	570	6	200	22		Xwc	May 1963	69	12	.1	D		6	170
2	Robert Gay	do.	1962	550	6	104			Xwc					D	6.5	3	90
3	do.	do.	1962	500	6	200	33		Xwc	Aug. 1962	18	2		D	7.1	6	240
549-1	Ted Rhodes	Hope Womble	1957	400	6	120	88		Xwc	June 1963	23			D	6.5	4	220
2	Herman Haines	C. L. Myers	1955	328		97	5	75	Cl		27	7		I			
550-1	Robert Rivera	Thomas Keyes		520	5	68	28	'40, 60	Cc		14	20		D	6.2	1	65
2	Jules Harris	do.	1962	580	6	147	15		Cc	Mar. 1962	66	2		D	5.2		230
3	Amos Mason	do.	1963	560	6	112	24		Cc			10		D	5.3	5	400
4	Charles Johnson	I. N. Petersheim	1959	585	6	127	36		Chp	Sept. 1959	98	10		D			
5	Walter Johnson	do.	1958	590	6	128	36	108	Chp	July 1958	100	15		D	4.7	5	300
551-1	Keystone Mushroom Co.	Daugherty	1922	420	8	100			Oc	July 1949	16	100		I			
2	T. Romero			635		95	21		Cc		20	3		D	4.9	1	70
3	M. Lightcap	C. L. Myers	1942	595	6	38			Ch	Nov. 1963	13			D		2	70
4[a]	J. H. Cornett		1918	610		27			pCbn		25			D		2	70
5	A. Armertrout	C. L. Myers		610		60			pCbn		18			D		3	130
6	Foster Semple	I. N. Petersheim	1955	520	6	101	41		Xwc		80			D	5.9	3	110
7	Stewart Fox	do.	1963	370	8	365	30		Xwc		25	0		A			
552-1	L. O. Kryder	Hope Womble	1957	650	6	56	46	36, 38, 40, 45, 50	pCbn	May 1957	12			D	5.8	3	135
2	Keystone Mushroom Co.	C. L. Myers	1923	420	8	200			Oc	Sept. 1950	17			A			
3	do.	do.		420	8	200			Oc	Sept. 1950	17			A			
4	Elvin Landis	do.		630		50			pCbn		25			D, S		6	325
5	Charles Michinock	Thomas Keyes	1963	660	5	60	45	50	pCbn	Oct. 1963	12	45		D	6.1	2	95
553-1	Howard Lantz	Hope Womble	1957	625	6	42	35	38, 40, 42	pCbn	May 1957	10			D	6.9	3	160
2	Bureau of Child Care, Farm and Vocational School	Clifford Myers	1950	505	6	131	60		Cc	Oct. 1963				P	6.2	2	60
3	J. H. Norris		1949	615	6	125	120	60, 85, 125	Chp		8	30		D	5.6	2	200
4	do.			610	6	68			Chp		50	4		D			
5	Richard McElhaney	Thomas Keyes	1963	660	5	100	25	67, 98	pCbn	Oct. 1963	40	40		D			
554-1	J. T. Foy		1962	630	6	96		44	pCbn	June 1963	33	3		D	6.6	2	80
2	Mrs. Everett Cowan, Sr.	C. L. Myers	1941	600	6	40			pCbn	June 1963	8			D	6.0	4	140
555-1	Carl Geesey	do.	1962	685	6	32	20		pCbn	Dec. 1962	24			D			
2	S. Kepiro	C. L. Myers	1962	685	6	52	41		pCbn	Nov. 1962	24			D	6.3	3	130
556-1	H. E. Nelms	Hope Womble	1957	670	6	83	76	34, 80	pCbn	June 1963	10	27		D	6.3	2	90
2	W. C. Smoker	D. M. Stoltzfus	1944	645					pCbn					D	6.4	6	240
557-1	M. G. Engel	C. L. Myers	1961	660		135		35	pCbn			1		D	6.4	5	200
2	Ralph and Ivan Stoltzfus	I. N. Petersheim	1922	575	6	80			pCbn	July 1963	17		8.92	D, S	6.2	9	325
558-1	J. H. Stoltzfus	Kauffman	1958	605		58	20		pCbn		33			D	5.8	6	250
559-2[a]	Elias Bawell			550	36	23			pCbn	July 1963	22			D	6.7	6	280
959-530-1	C. J. Ranney	Calvin Powell	1963	470	6	169			pCbgb	Dec. 1963	20			D	7.0	2	120
2	G. K. Crozier, III	Thomas Keyes	1963	510	6	95	23		pCbgb	Nov. 1963	29	15		D	6.4	5	230
3	Woolard	do.	1962	470	6	60	44	14, 28, 34, 38, 48, 57	Xg	Mar. 1962	6	40+	1.87	D	6.4	3	140
531-1	E. G. Grosvenor	C. S. Gerber		440		70			pCbgb	Dec. 1963	5	21		D	6.8		90
2	S. B. Eckert			410	4	130			pCbgb		60			D	7.1	4	155
532-1	Vista Farms	Artesian Well Drilling Co.	1962	450	6	85	30		pCbgb	May 1962	35	15		D			
2	do.	do.	1962	440	6	76	51		pCbgb	May 1962	25	20		D		3	125

Table 5. Record of drilled wells—Continued

Well number	Owner	Driller	Date completed	Altitude above sea level (feet)	Diameter of casing (inches)	Total depth (feet)	Depth to bottom of casing (feet)	Depth to water-bearing zones (feet)	Aquifer	Static water level: Date measured	Static water level: Depth below land-surface (feet)	Reported yield (gpm)	One hour specific capacity (gpm/ft)	Use	Field analyses of water: pH	Field analyses of water: Hardness (gpg)	Field analyses of water: Specific conductance (micromhos at 25°C)
							Chester County—Continued										
959–532–3	Church of Goshenville	Thomas Keyes	1961	425	5	120	60	64	pCbgb	Oct. 1961	15	7		P	6.6	3	105
4	Arthur Comins	do.	1963	450	6	79	44	37, 50, 54	pCbgb	Mar. 1963	46	20	4.18	D	6.7	4	160
5	do.	do.	1959	490	6	187			pCbgb			1		A			
533–1	James Williams	do.	1957	440	6	79	54		Xg	Feb. 1957	25	12		D		3	90
2	Bittersweet Glen Homes	do.	1963	440	6	120	42	50, 72, 95	pCbgb	Oct. 1963	30	25		P			
3	J. F. Page	do.	1962	410	5	50	28	40	pCbgb	Aug. 1962	6	60+		D	6.8	3	108
4	C. J. Albrecht	I. N. Petersheim	1962	410	6	75	47	58, 65	pCbgb	July 1964	19	100	7.27	I	6.5	3	130
5	do.	Thomas Keyes	1954	425		150			pCbgb	July 1964	42	4	.13	D			
6	Russell Hicks	I. N. Petersheim	1962	410	6	140	38	50, 106	pCbgb	July 1962	30	15		D	6.6	7	305
534–1	David Wright	Sadler	1948	460		100	60	80	pCbgb	1948	10			A			
2	do.	Thomas Keyes	1955	425	6	110			pCbgb	Dec. 1963	25			P	7.2	2	120
536–1	Wilmer Sager			470	6	55			Xwm	Dec. 1963	14			D, S	6.2	3	145
537–1	Fred Gordon		1958	440		60			Xwm					D	6.4	3	130
538–1	Edward Simcox	Thomas Keyes	1962	515	5	200	22		Xwc	Mar. 1962	30	1		D		7	190
2	N. C. Brown	I. N. Petersheim	1963	500	5	120	20	106	Xwc	July 1963	40	8	.15	D	6.8	9	370
3	Zane Reed	Thomas Keyes	1964	530	6	144			Xwc	May 1964	50	½		D	7.0	11	360
539–1	Stephen Simcox	do.	1962	470	5	110	15	17, 72, 104	Xwc	Mar. 1962	46	15		D		4	140
2	A. E. Creamer		1950	365	6	105			Xpc	Nov. 1963	50		.31	D	6.1	2	95
541–1	Harold Strong			440	6	125			Xwc	Nov. 1963	11		9.05	D	5.0	2	85
2	YMCA Camp Lookout	Thomas Keyes	1963	300	5	158	23	35, 50	Xwc	Nov. 1963	18	5		P	7.1	3	95
3	do.	do.	1963	310	5	153	21	23	Xwc	Nov. 1963	10	12		P			
542–1	H. W. Rodgers		1958	550	6	140		80, 100, 120	Xwc			4		D	6.7	5	220
2	do.		1920	515	6	108			Xwc	Nov. 1963	60	8		D	6.0	2	90
543–1	R. B. Hardin	Thomas Keyes	1957	500	6	125	23	120	Xwc	Apr. 1957	25	7		D		2	60
544–1	Edward Caldwell	C. L. Myers	1958	330	6	75	70		Xwc	Summer 1958	11			A	5.4	2	155
2	G. O. Carlson, Inc.	Yocum		320	6	90			Oc	Oct. 1963	12			D	5.4	3	140
3	do.			350	10	1,000	100		Xwc					I	6.5	3	90
4	do.			335	10	54			Oc	Oct. 1963	16	30		I			
5	A. F. Travaglini	Yocum		390	6	285	200		Xwc		40			D	6.6	2	60
6	Paul Nelms	Thomas Keyes	1962	415	6	197	155	160	Xwc	Oct. 1962	79	20		D		2	60
7	George Hiddleson	McNelly		285	6	85	50	50, 85	Ce	Fall 1963	14	15		D	7.4	14	550
8	Harold Nelms	Thomas Keyes	1961	325	6	90	56	84	Oc	Oct. 1961	22	175		D			
545–1	James Marsh	C. L. Myers	1962	365	4	202	185		Xwc	June 1962	30			D	6.3	1	20
2	Zinn's Diner			310		200	100		Ce		20	150		P			
3	Frank Knaver	Herbert Hornberger		330	6	68	60		Cl		Flowing	40		D			
4	Caln Township	C. L. Myers	1961	310	6	150	4	145	Ck			10		P		6	350
546–1	Peter Mankow	McCorkle		330	6	42	21	[illegible]	Cl	[illegible]	[illegible]	[illegible]		D	7.8	10	[illegible]
3	[illegible]	do.		350	6	65		40–50	Ck					D	7.5	8	325

5	V. A. Hospital		1943	400	15	300			Cv	Jan. 1944	50	665		P			
548–1	Cecil Mahon	C. L. Myers	1962	600	6	120	21		pCbn	June 1963	34	13	.58	D	6.0	2	75
2	Producers Coop. Exchange	do.	1954	360	12	150	60		Cl	1954	30	150		I			
3	do.	do.	1955	360	8	400	100		Cl	1955	50	60		I	7.1	15	510
4	do.	do.	1956	360	8	225		30, 120–125	Cl	Sept. 1963	31	15		A			
549–1	Paul Rubincam	do.	1938	345	6	118		105	Cl	Sept. 1963	34	25		I	7.0	28	1,000
2	George Taylor	Hope Womble	1953	350		68		64	pCbn	Summer 1962	4			D		5	350
3a	Ann Ruczhek			340		8			Ch	Nov. 1963	5			D		2	100
4	L. Brown	C. L. Myers	1963	480	6	93	60		pCbn	1963	40			D		6	300
550–1	John Wilson	Hope Womble	1957	440	6	50	34	38	pCbn	May 1957	15	9		D	5.9	7	340
2	Clara Curry	do.	1957	575	6	42	22	29, 32	Cc	July 1957	16	20		D	6.2	6	200
3	Ernest Brickus	do.	1957	585	6	47	28	39, 43, 47	pCbn	July 1957	6	30		D			
4	Andrew Tate	do.	1957	600	6	60	20	48, 56	pCbn	Mar. 1957	28	8		D	6.1	4	180
5	Harold Thompson		1949	585	6	70			Cc	Aug. 1963	54			D	5.5	3	100
6	Ben Scott			585	6				pCbn	Nov. 1963	63			D		4	220
7	Norman Hines			420		80			Ch	Nov. 1963	36			D	5.1	2	80
8	Brandywine Area School Board			560	6	42			Ch		30			P			
9	W. T. Grier, Jr.	I. N. Petersheim	1964	590	6	45	29		pCbn		25	20		D			
551–1	Nick Cazzille	C. L. Myers	1950	455	6	42			Xg		8			D		4	180
2	Nick Cazzille, Jr.	Hope Womble	1958	490		72			pCbn		27			D			
3	Brandywine Area School Board	C. L. Myers		605	6	42	42		pCbn		8	25		P			
552–1	Alvin Supplee			560	6	30			pCbn	June 1963	8		1.41	D	6.4	3	110
2	Eleanor Wertz	C. L. Myers		620		100			Xp					D	5.8	6	250
3a	John Robinson			660	36	20			pCbn	Oct. 1951	17			D			
4	J. Blecker	I. N. Petersheim	1954	680	6	60	32	35–40	pCbn	Nov. 1963	40	25		D		3	130
553–1	H. W. Smith	C. L. Myers	1957	640	6	85	20		pCbn	June 1963	11	30		D	6.0	2	90
2	Willard Cox	Hope Womble	1962	685		136			Xg					D	6.1	1	50
554–1	C. P. Klinovski	Robert Mattson	1962	720		104		45	Xs	1962	60	4		D	6.4	3	105
2	John Kennel	Hope Womble	1961	640	6	50			pCbn	1961	35			D	6.4	6	240
555–1	L. E. Miller	E. H. Rankin	1957	665		72	30	66	pCbn	June 1963	23		.17	D	6.4	4	200
2	Henry Downing	C. L. Myers	1959	725	6	90	74		Ch	June 1963	23			D	6.0	1	15
556–1a	Daniel Stoltzfus			720		31			pCbn	June 1963	23			D	5.9	3	225
2	J. L. King	C. L. Myers	1959	735					Ch					D, S	5.7	2	100
3	Clayton Hughes	I. N. Petersheim	1963	690	6	65	35	40, 60	Xg	July 1963	12	20		D			
557–1	J. R. Glick			715		60			pCbn			0		A			
2a	Harry Jackson			730	48	18			pCbn	June 1963	15			D	6.4	4	130
3	L. S. Lapp	Morris Bailey	1955	760	6	120			Ch	June 1963	22		0.053	D	6.4	2	70
	Delaware County																
952–530–1	Joseph Mascaro	Frank Wiley	1951	302	6	145	28	100, 135	pCbgg	July 1951	20	45		D	6.6	5	290
2	do.	do.	1924	295	6	50			pCbgg		15	15		D	6.1	6	325
3	John Pusik	Thomas Keyes	1963	295	6	154	32		pCbgg	Mar. 1963	18	2½		D	7.3	15	500
531–1	J. E. Webb			370		90			pCbn					D	5.9	4	165
532–1	Concord Country Club			405	6	90			pCbn		Flowing	23		P	5.8	6	280
533–1	James Boyles	Keystone Well Drilling Co.	1949	380	5	132	10	32, 105, 130	pCbn	Oct. 1963	60	20+		D	6.5	4	180
534–1	H. F. Jones	C. L. Myers	1955	360	6	103	54		Xg			16		D	7.2	10	400
953–530–1	F. Gibson	Thomas Keyes	1962	390	5	187	36	178, 181	Xg	Jan. 1962	35	3½		D		5	195
2	Armand DeCola	Charles Lauman	1962	385	6	72	47	30, 72	pCbgb	Jan. 1962	22	40		D		3	110
3	Charles Naspinski	do.	1961	360	6	134	33	21, 93, 134	pCbgb	Aug. 1961	16	10		D		4	150
4	George Simpson	do.	1961	355	6	80	30	18, 80	pCbgb	Aug. 1961	24	14		D		5	190

Table 5. Record of drilled wells—Continued

Well number	Owner	Driller	Date completed	Altitude above sea level (feet)	Diameter of casing (inches)	Total depth (feet)	Depth to bottom of casing (feet)	Depth to water-bearing zones (feet)	Aquifer	Date measured	Depth below land-surface (feet)	Reported yield (gpm)	One hour specific capacity (gpm/ft)	Use	Field analyses of water: pH	Hardness (gpg)	Specific conductance (micromhos at 25°C)
								Delaware County—Continued									
953–530–5	K. E. Holloway	Thomas Keyes	1962	395	5	115	42	50	Xg	Aug. 1962	30	5		D			
6	W. C. Morrison	do.	1962	390	5	65	28	38, 54	Xg	June 1962	25	8		D			
7	Ernest Atene	do.	1962	380	5	65	38		Xg	June 1962	10	8		D			
8	M. D. Hauser	do.	1962	380	5	60	27	35	Xg	Sept. 1962	17	20		D	6.5	3	115
9	Community Water Service Co.	do.	1963	285	10	101	24	44, 67, 88	pCbgb			125	9.0	P			
10	Edward Hassen	do.	1963	415	5	90	50		pCbgb	Sept. 1963	35	9		D	6.2		105
531–1	Robert Brown	Harvey P. Martin and Sons	1963	365	6	95			pCbn	Nov. 1963	17			D	7.1	2	75
532–1	The Old Mill	Frank Wiley	1958	325	8	80			Xg					P	5.8	4	160
2	Concord Country Club	Charles Mock	1962	410	6	110	35	40–60	Xg			4		P	7.0	4	225
3	do.	do.	1962	370	6	90	20		Xg	Spring 1962	3	35		P	6.1	3	150
4	J. F. Blackman	J. R. Turk	1960	360	6	130	10	32, 49, 124	Xg			8		D			
5	do.	do.	1960	390	6	208	10	32, 75, 180	Xg			4		D			
6	do.	do.	1960	395	6	167	20	35, 90	Xg			3		D			
7	do.	do.	1961	380	6	209	23	45	Xg					D			
533–1	Thimm Bros. Greenhouse	Keystone Well Drilling Co.	1954	450	6	120	40		pCbgb			15		I			
2	do.	do.	1954	460	6	150	40	80, 100	pCbgb	1954	85	6		I	6.2	6	315
3	do.	do.	1961	450	6	110	40		pCbgb	1961	35	17		I	5.8	9	575
4	do.			450	5	85			pCbgb			3		I	5.7	9	460
5	Lester Adams		1951	455	6	84	50	40, 60	pCbn	Nov. 1963	28	4		D	6.3	5	255
6	Thimm Bros. Greenhouse	R. G. Fetters	1963	440	6	200	45	30, 180–200	pCbgb			55		I			
534–1	Edward Lawrence	Charles Mock	1959	405	6	85			Xg			4		D	6.3	3	140
954–530–1	Robert West	Artesian Well Drilling Co.	1958	440	6	102	22		pCbgb	April 1963	41	3	.06	D		4	150
531–1	E. A. Anderson	do.	1959	460	6	82	20		Xg	May 1963	23	9		D		4	140
2	R. H. Nelson	Frank Wiley	1947	465	6	68	33	40, 68	Xg	1947	24	20		D	6.5	2	105
3	Lawson Stinson	Thomas Keyes	1963	360	5	100	68	77	Xg	Sept. 1963	40	10		D			
4		do.	1963	350	5	105	75	79, 98	Xg	1963	30	8		D			
532–1	C. K. Sloan	do.	1963	415	5	96	32	26, 36–37	pCbn	May 1963	26	10	1.63	D		9	370
2	Joseph Polley	Charles Lauman	1961	400	6	160	51		pCbn	Dec. 1961	20	5		D		4	150
3	do.	do.	1961	395	6	65	35	45, 65	pCbn	Dec. 1961	25	18	3.81	D		5	160
4	Northrope Jones	Thomas Keyes	1962	405	6	61	26	29–34, 37–38, 47–49	pCbn	Oct. 1962	9	35+		D	6.5	4	120
5	Dutcher	do.	1963	450	5	150	20		pCbn	May 1963	30	25		D	6.5	5	200
6	J. F. Blackman	J. R. Turk	1961	400	6	74	53		Xg			6		D			
7	do.	do.	1961	385	6	45	25		Xg			15		D			
8	Community Water Service Co.	Thomas Keyes	1964	365	12	185	22	5, 12, 50–55, 99	Xg	Apr. 1964	2	125	3.80	P	7.2	4	195
533–2	R. W. Godbey	do.	1962	400	6	202	31	20, 45,	pCbn	April 1962	5	3		D	7.0	8	325
955–530–1	[illegible]	do.	1963	355	6	202	30	42, 72–81	Xg	Jan. 1963	[illegible]	[illegible]	.08	D		5	170

								83, 91								
5	Ernest Taggart, Jr.	do.	1963	400	5	84	58	40, 63	pCbgb	Dec. 1963	35	12		D			
6	William Whitehead	do.	1963	400	5	60	32	53	pCbgb	May 1963	30	30		D	6.4	2	70
7	John Cooke	do.	1963	400	5	60			pCbgb					D	6.7	4	165
8	Aubrey Smith	do.	1963	325	5	68	34	43, 60	pCbn	July 1963	4	30		D	6.5	3	120
531-1	Cheyney State College			280	4	300			pCbn	1961	33	25		P			
2	do.	Ridpath and Potter	1951	260	8	300	47		pCbn	Aug. 1951	16	201		P			
3	do.	Kohl Bros.	1963	260	8	300	52	25, 32, 80–83, 264	pCbn	Summer 1963	18	106		P			
4	William O'Shields			420	6	50			Xg	Nov. 1963	10		.02	D	6.1	2	100
5	Charles Brown	Thomas Keyes	1963	360	5	43	23	23–26, 35–37	Xg	Nov. 1963	12	50		D	6.0		155
532-1	Mary Simpler	do.	1963	355	6	166	51	81, 155	pCbn	Fall 1963	11	30+		D	7.4	5	205
956-530-1	J. S. Lees, Sr.	Cressman	1951	375	6	36	30		Xg	1951	7	6+		D	6.5	3	130
2	J. S. Carter		1955	320	6	52			pCbn	Dec. 1961	13	15		D	5.8	3	170
3	J. A. Leiper	Thomas Keyes	1963	355	6	142	34	20, 24, 28, 34	Xg	Sept. 1963	5	½		A			
4	do.	do.	1964	335	6	63	37	23, 35, 41, 59	Xg	Sept. 1964	10	30		D	6.5	3	120
531-1	Cheyney State College		1940's	300	4	280			pCbn	Fall 1962	57	25		P	6.5	3	180
							Lancaster County										
952-559-1	Charles Huckins			470	6	70			Xpc	Aug. 1963	36			D	6.1	7	120
953-559-1	Ruth W. Jones	E. H. Rankin	1951	400		120			Xpc		40			D	5.8	3	100
956-559-1	John and Robert Metzler			460		90			Oc					D, S	7.0	14	540
2	John Metzler	Ralph Myers	1961	460	6	70		40	Oc	July 1963	10	7	.4	D	7.0	16	50
3	John Wishner			540		135			Xwc	July 1963	85			D	5.8	2	110
958-558-2[a]	Andrew Gilbert			635	30				pCbn	July 1963	15			D	6.1	5	220
559-3	Borough of Christiana	I. N. Petersheim	1960	640	8	308			pCbn	Aug. 1960	10	70		P			
4	do.	Walter Slauch	1954	660	8	225	25	100	pCbn					P			
959-558-1	G. B. H. Stern	E. H. Rankin	1963	790	6	119	13	95	Cc	Aug. 1963	82	6	.21	D	5.6	1	20
2	W. A. Hanna			790	6	45			Ch		34			D	5.4	2	150
559-1	George Killinger			630		28	28		Chp		12			D, S	5.4	1	50
2	E. J. Kennel	I. N. Petersheim	1959	750	6	222	30	170, 215	Cc	June 1963	64	15	.2	D	5.8	3	150
S-1[b]	R. C. Zander			570					Ca					D	5.6	1	60
S-2[b]	do.			585					Chp					D	5.4	1	20

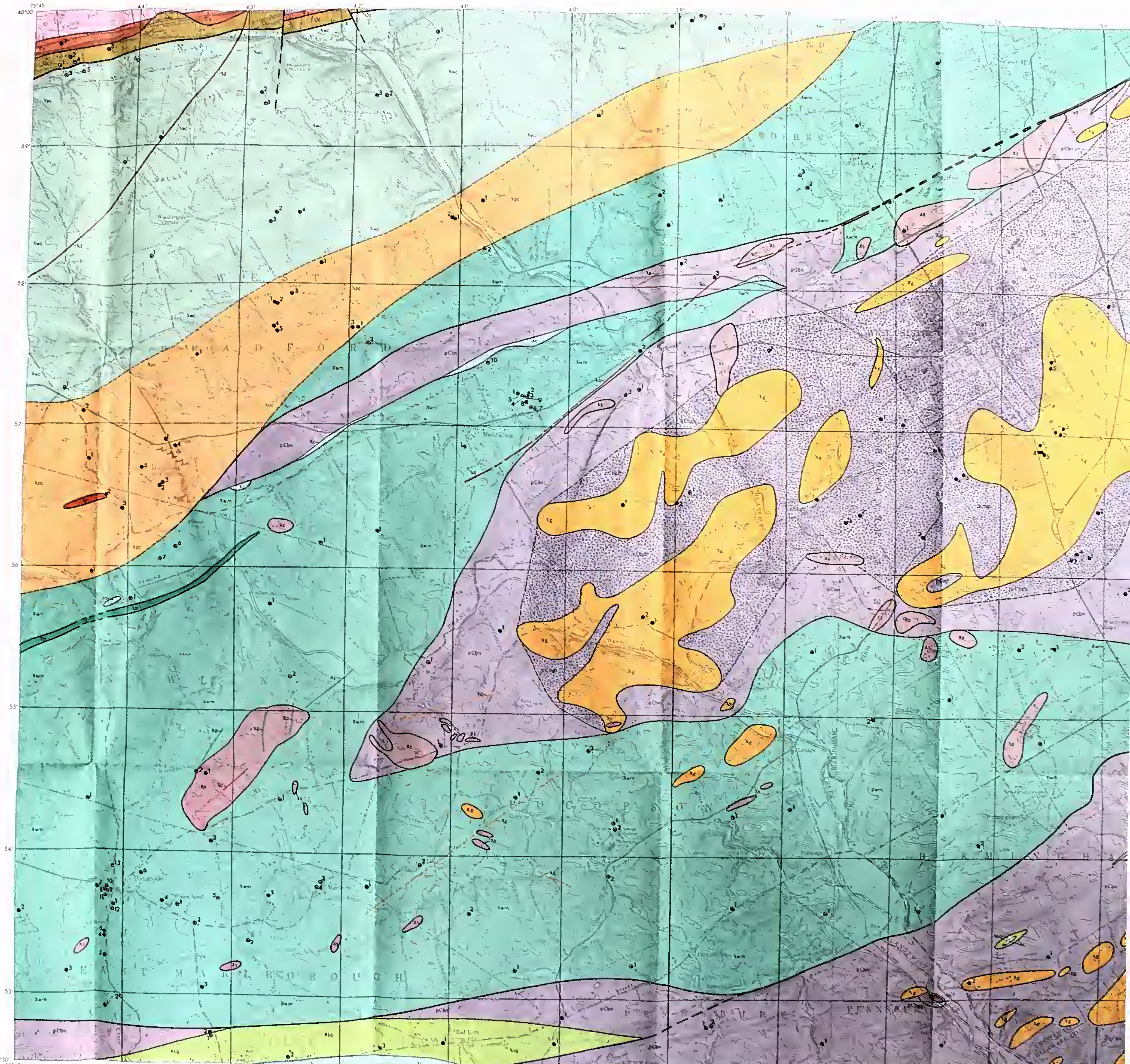
[a] Dug well.
[b] Spring.

Table 6. Chemical analyses of ground water

Well number	Silica (SiO_2)	Total iron (Fe)	Total Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (residue at 180°C)	Hardness as $CaCO_3$: Calcium magnesium	Hardness as $CaCO_3$: Noncarbonate	Field analyses: pH	Field analyses: Hardness (grains per gallon)[b]	Field analyses: Specific Conductance (micromhos at 25°C)	ABS
Chester County																			
952–549–1	26	0.18	0.00	36	13	15	1.0	46	58	17	0.0	65	265	144	106	6.0	10	410	0.15
953–542–3	20	.31	.05	18	8.3	8.7	3.2	46	47	9.2	.2	2.2	146	79	42	7.2	5	220	.02
555–2	11	.14	.00	7.6	3.6	6.1	.5	12	3.8	9.2	.0	25	86	34	24	6.0	2	120	.08
3	12	.16	.00	16	8.0	22	1.2	14	1.4	32	.0	74	200	73	62	5.7	4	300	.03
954–533–1	26	7.5	.20	12	6.8	6.0	6.0	51	31	4.7	.2	.2	125	58	16	6.8	4	180	.01
554–1	15	1.1	.27	14	4.6	3.8	.2	68	6.2	1.4	.0	.2	79	54	0	6.6	3	115	.01
955–539–1	30	.10	.00	20	6.3	12	.2	50	33	6.2	.1	19	156	76	35	6.6	5	215	.01
549–1	13	.21	.00	62	8.9	3.0	1.0	206	15	6.0	.0	10	234	191	22	7.2	11	380	.01
956–542–1	20	.03	.00	21	7.3	10	3.0	64	4.6	17	.0	31	170	83	30	6.4	6	250	.05
543–7	18	.17	.00	35	20	7.4		138	39	10	.1	22	227	170	56	[a]7.8	..	[a]359	...
547–1	14	.50	.00	18	5.4	10	.5	60	14	9.3	.0	21	127	67	18	7.3	5	210	.01
555–2	7.6	.09	.03	4.0	5.4	5.6	.7	8	.6	7.1	.1	31	76	32	26	5.8	2	115	.01
957–532–2	25	.16	.02	10	3.6	8.5	3.1	30	22	9.7	.2	0.0	108	40	16	[a]6.3	4	190	.07
958–536–1	25	.07	.00	20	23	17	2.5	156	36	9.2	.0	11	221	145	17	6.4	9	360	.11
547–1	6.9	.08	.00	18	6.8	4.5	.2	78	6.3	4.9	.0	8.1	105	73	9	[a]6.8	6	170	.06
3	4.6	.31	.00	15	14	6.1	.2	74	34	4.6	.0	9.3	138	95	35	7.1	6	240	.02
550–3	5.6	.34	.22	16	11	36	2.5	4	56	28	.0	76	244	85	82	5.3	5	400	.46
553–3	7.9	.10	.18	4.4	5.6	18	3.5	6	10	16	.0	48	132	34	29	5.6	2	188	.39
557–2	18	.10	.00	34	16	12	2.2	52	49	22	.3	60	262	151	109	6.2	9	375	.02
959–532–2	26	.63	.02	8.0	3.4	6.1	1.1	39	3.8	4.8	.1	9.1	101	34	2	[a]6.4	3	125	.03
544–7	11	.10	.03	70	17	16	1.6	274	20	19	.0	15	319	245	20	7.4	14	550	.15
546–1	7.9	.06	.00	35	20	4.7	.9	182	17	7.6	.0	8.8	202	170	21	7.8	10	360	.02
2	9.3	.34	.00	21	12	1.5	.2	119	.6	4.4	.0	6.9	116	102	5	7.6	6	195	.01
3	9.3	.17	.00	30	18	3.0	7.0	176	15	3.6	.1	3.4	178	149	5	7.5	9	325	.01
547–5	12	.29	...	25	15	5.1		146	5.2	4	...	5.5	144	...	...	[a]7.9	..	[a]249	...
557–3	14	.10	.00	4.8	2.4	3.4	2.5	20	.8	3.1	.1	12	59	22	6	6.2	2	75	.00
Delaware County																			
952–530–2	15	.17	.00	29	12	15	1.7	77	47	14	.1	35	226	122	59	6.2	8	350	.04
534–1	21	.13	.00	17	5.4	6.7	1.5	50	28	3.3	.1	7.9	119	65	24	6.2	4	180	.01
954–532–1	17	.16	.00	32	13	15	6.0	92	50	14	.1	28	232	134	58	[a]7.0	9	370	.12
955–530–1	28	2.5	.09	19	4.6	4.5	2.0	63	19	5.6	.0	1.1	131	67	15	[a]7.2	5	170	.06
Lancaster County																			
956–559–2	6.5	.10	.00	85	9.4	3.0	2.0	182	47	17	.1	53	357	251	102	7.4	14	520	.01

DEPARTMENT OF INTERNAL AFFAIRS
John K. Tabor, Secretary

COMMONWEALTH OF PENNSYLVANIA



Base from U. S. Geological Survey Topographic Quadrangles

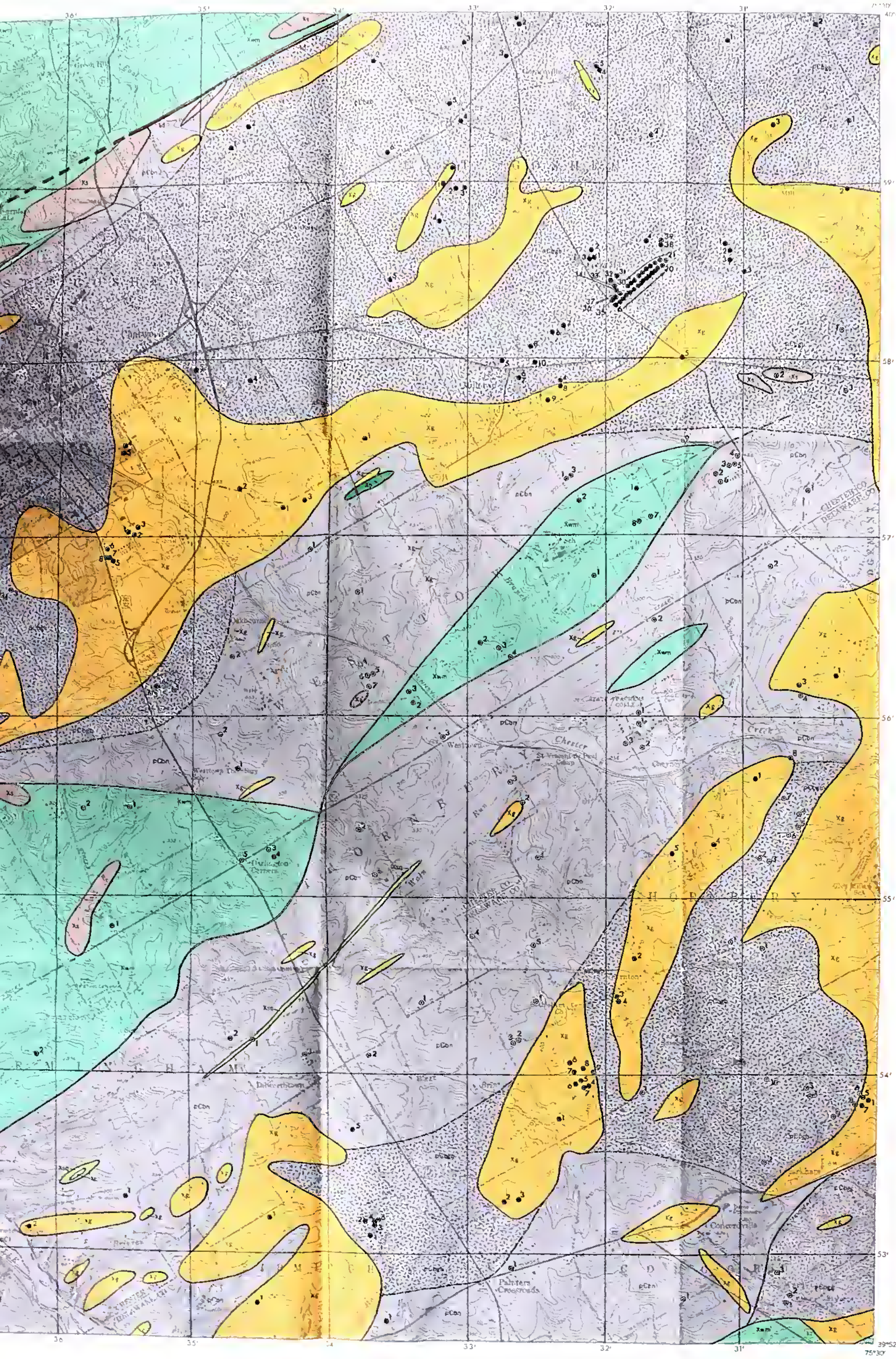
APPROXIMATE MEAN DECLINATION, 1953

SCALE 1:24000

CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

PLATE 1. GEOLOGY AND WELL LOCATIONS IN THE WEST CHESTER UNIONVILLE QUADRANGLES, PENNSYLVANIA

1968



Geology by F. Bascom and G. W. Stose, 1932

Well locations by C. W. Poth, 1966

EXPLANATION

ROCKS OF SEDIMENTARY ORIGIN

ORDOVICIAN

Conestoga Limestone

Thin-bedded limestone, has shaly partings, in part conglomeratic at base. Median reported yield of wells is 20 gpm, the yields range from 7 to 175 gpm. Median hardness of water is 14 grains per gallon.

CAMBRIAN

Elbrook Limestone

Finely laminated impure marble. Median reported yield of wells is 40 gpm, the yields range from 15 to 150 gpm. Median hardness of water is 14 grains per gallon.

Ledger Dolomite

Granular crystalline dolomite. Median reported yield of wells is 25 gpm, the yields range from 7 to 150 gpm. Median hardness of water is 14 grains per gallon.

PRECAMBRIAN – LOWER PALEOZOIC (?)
Age uncertain

Peters Creek Schist

Fine-grained laminated chlorite mica schist. Median reported yield of wells is 11 gpm, the yields range from 0 to 312 gpm. Median hardness of water is 3 grains per gallon.

Wissahickon Formation

Chlorite phase, Xwc, typically a phyllite, contains chlorite, albite, and muscovite. Median reported yield of wells is 8 gpm, the yields range from 0 to 80 gpm. Median hardness of water is 3 grains per gallon. Muscovite phase, Xwm, coarsely crystalline schist, contains muscovite, quartz, and feldspar. Median reported yield of wells is 10.5 gpm; the yields range from 0 to 350 gpm. Median hardness of water is 3 grains per gallon.

Cockeysville Marble

Medium- to coarse-grained saccharoidal marble. Median reported yield of wells is 20 gpm, the yields range from 3 to 330 gpm. Median hardness of water is 6 grains per gallon.

Setters Quartzite

Quartzite, quartzitic schist, and locally, mica gneiss. Median reported yield of wells is 16 gpm; the yields range from 12 to 33 gpm. Median hardness of water is 7 grains per gallon.

PRECAMBRIAN

Franklin Limestone

Coarsely crystalline graphitic marble. Present only in small area at Brinton Bridge. Unimportant as a source of water.

Baltimore Gneiss

Contorted, banded gneiss, p€bn, composed of quartz, feldspar, and biotite, in places intruded by gabbro, p€bgb; locally graphitic, p€bgg. Median reported yield of wells in "normal" phase, p€bn, is 17 gpm, the yields range from 1 to 270 gpm, in gabbro-intruded phase, p€bgb, the median reported yield is 11 gpm, the yields range from 3½ to 125 gpm, graphitic phase, p€bgg, is unimportant as a source of water. Median hardness of water is 6, 6, and 7 grains per gallon, respectively.

ROCKS OF IGNEOUS ORIGIN

TRIASSIC

Diabase

Medium- to fine-grained rock, present as dikes. Unimportant as a source of water.

PRECAMBRIAN – LOWER PALEOZOIC (?)

Gabbro

Chiefly calcic plagioclase and hypersthene or augite, may contain quartz. In small masses in Wissahickon, hornblende replaces pyroxenes. Median reported yield of wells is 10 gpm, the yields range from 3½ to 125 gpm. Median hardness of water is 4 grains per gallon.

Serpentine

Fibrous to massive magnesium-rich rock. Median reported yield of wells is 18 gpm, the yields range from 4 to 80 gpm. Median hardness of water is 5 grains per gallon.

Pegmatite

Composition ranges from granite to gabbro, present as numerous small sill-like bodies. Unimportant as a source of water.

SYMBOLS

Geologic contact, dashed where uncertain.

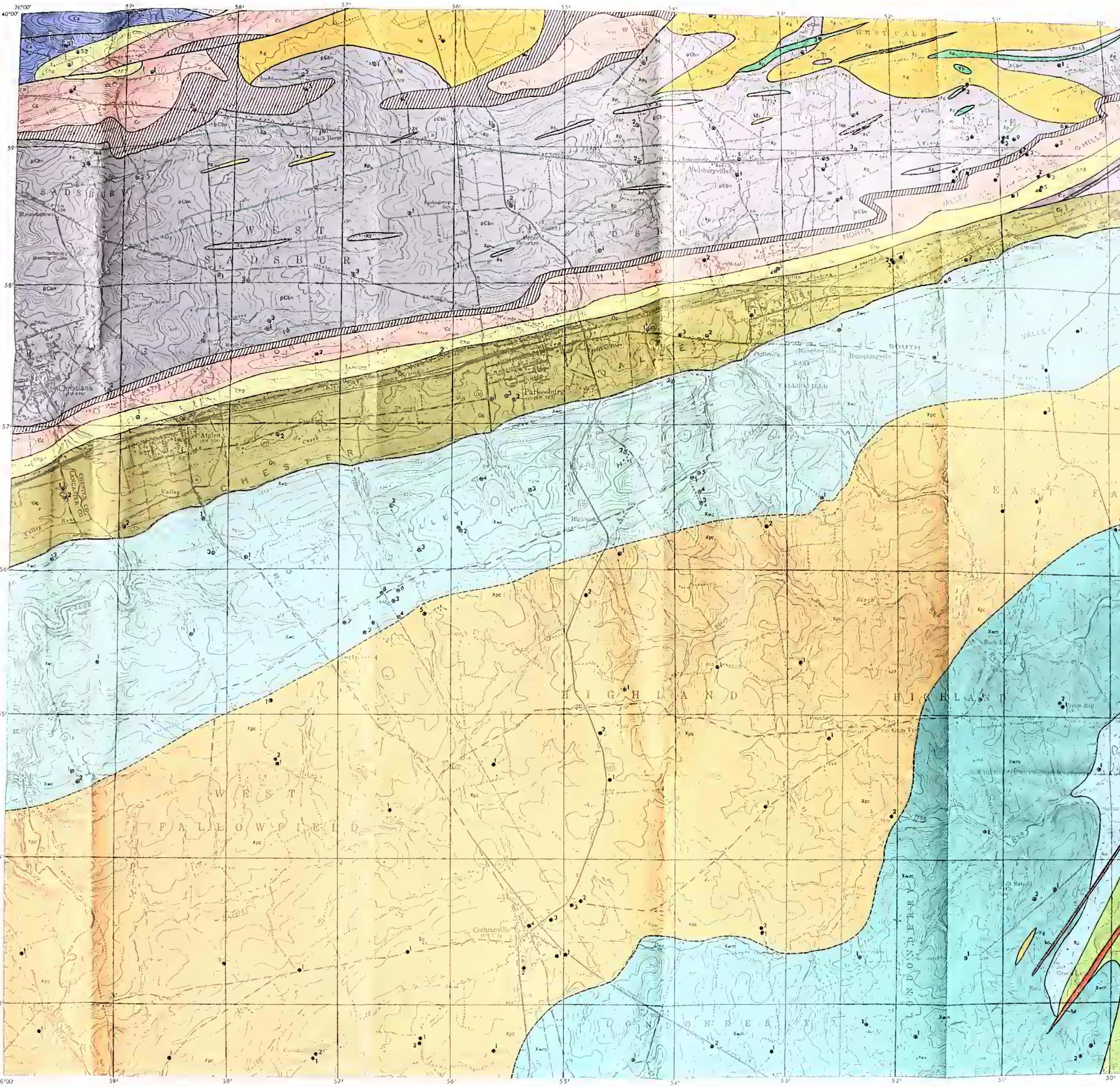
Fault, dashed where uncertain.

Well

THE WEST CHESTER AND
NNSYLVANIA

DEPARTMENT OF INTERNAL AFFAIRS
John K. Tabor, Secretary

COMMONWEALTH OF PENNSYLVANIA



Base from U. S. Geological Survey Topographic Quadrangles

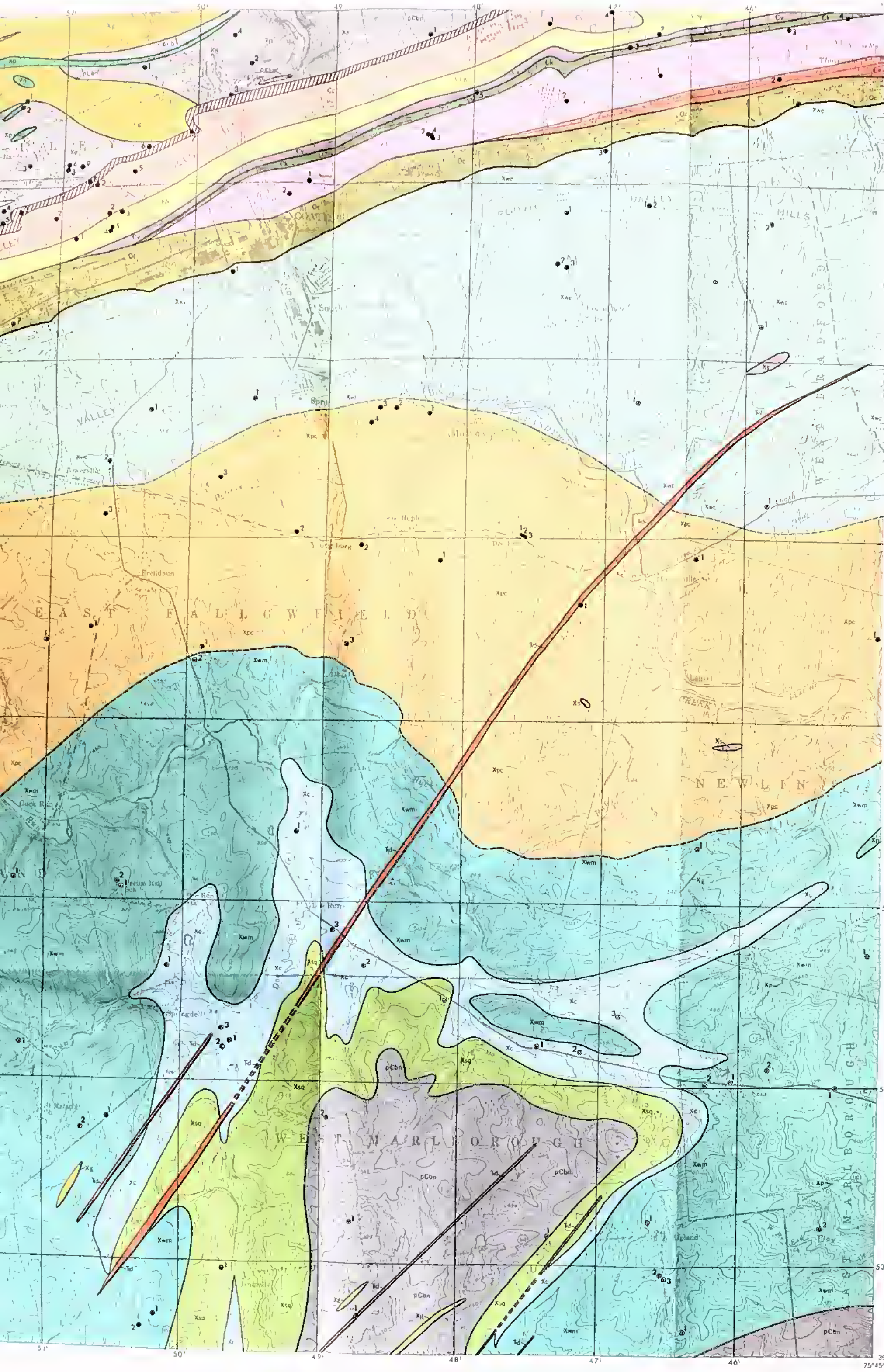
SCALE 1:24000

CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

APPROXIMATE MEAN DECLINATION 1953

PLATE 2. GEOLOGY AND WELL LOCATIONS IN THE COATESVILLE
PARKESBURG QUADRANGLES, PENNSYLVANIA

1968



Geology by F. Bascom and G. W. Stose, 1932

Well locations by C. W. Poth, 1966

HE COATESVILLE AND
SYLVANIA

EXPLANATION

ROCKS OF SEDIMENTARY ORIGIN

ORDOVICIAN

Oc

Conestoga Limestone

Thin-bedded limestone, has shaly partings, in part conglomeratic at base. Median reported yield of wells is 20 gpm; the yields range from 7 to 175 gpm. Median hardness of water is 14 grains per gallon.

CAMBRIAN

Ce

Elbrook Limestone

Finely laminated impure marble. Median reported yield of wells is 40 gpm; the yields range from 15 to 150 gpm. Median hardness of water is 14 grains per gallon.

Cl

Ledger Dolomite

Granular, crystalline dolomite. Median reported yield of wells is 25 gpm; the yields range from 7 to 150 gpm. Median hardness of water is 14 grains per gallon.

Ck

Kinzers Formation

Micaceous limestone and calcareous mica schist. Unimportant as a source of water.

Cv

Vintage Dolomite

Massive granular dolomite. Median reported yield of wells is 334 gpm; the yields range from 3 to 665 gpm. Median hardness of water is 4 grains per gallon.

Ca

Antietam Quartzite

Laminated quartzite. Unimportant as a source of water.

Chb

Harpers Schist

Sandy micaceous schist; has thin quartzite beds. Median reported yield of wells is 14 gpm; the yields range from 4 to 30 gpm. Median hardness of water is 2 grains per gallon.

Cc

Chickies Quartzite

Granular quartzite Cc massive and thin bedded; contains some quartz and mica schist. Conglomeratic Hellam Member, Ch, at base. Median reported yield of wells in Chickies is 12 gpm, the yields range from 2 to 20 gpm. Median hardness of water is 2 grains per gallon.

PRECAMBRIAN – LOWER PALEOZOIC (?)

Age uncertain

Xpc

Peters Creek Schist

Fine-grained laminated chlorite mica schist. Median reported yield of wells is 11 gpm; the yields range from 0 to 312 gpm. Median hardness of water is 3 grains per gallon.

Xwc | Xwm

Wissahickon Formation

Chlorite phase, Xwc, typically of phyllite, contains chlorite, albite, and muscovite. Median reported yield of wells is 8 gpm; the yields range from 0 to 80 gpm. Median hardness of water is 3 grains per gallon. Muscovite phase, Xwm, coarsely crystalline schist, contains muscovite, quartz, and feldspar. Median reported yield of wells is 10.5 gpm; the yields range from 0 to 350 gpm. Median hardness of water is 3 grains per gallon.

Xc

Cockeysville Marble

Medium- to coarse-grained saccharoidal marble. Median reported yield of wells is 20 gpm; the yields range from 3 to 330 gpm. Median hardness of water is 6 grains per gallon.

Xsq

Setters Quartzite

Quartzite, quartzitic schist, and locally, mica gneiss. Median reported yield of wells is 16 gpm; the yields range from 12 to 33 gpm. Median hardness of water is 7 grains per gallon.

PRECAMBRIAN

pCbn
pCbgg

Baltimore Gneiss

Contorted, banded gneiss, pCbn, composed of quartz, feldspar, and biotite, locally graphitic, pCbgg. Median reported yield of wells in "normal" phase, pCbn, is 17 gpm; the yields range from 1 to 270 gpm; graphitic phase unimportant as a source of water. Median hardness of water is 6 and 7 grains per gallon, respectively.

ROCKS OF IGNEOUS ORIGIN

TRIASSIC

Td

Diabase

Medium- to fine-grained rock, present as dikes. Unimportant as a source of water.

PRECAMBRIAN – LOWER PALEOZOIC (?)

Age uncertain

Xg

Gabbro

Chiefly calcic plagioclase and hypersthene or augite; may contain quartz. In small masses. In Wissahickon, hornblende replaces pyroxenes. Median reported yield of wells is 10 gpm; the yields range from ½ to 125 gpm. Median hardness of water is 4 grains per gallon.

Xs

Serpentine

Fibrous to massive magnesium-rich rock. Median reported yield of wells is 18 gpm; the yields range from 4 to 80 gpm. Median hardness of water is 5 grains per gallon.

Xp

Pegmatite

Composition ranges from granite to gabbro; present as numerous small sill-like bodies. Unimportant as a source of water.

SYMBOLS

Geologic contact, dashed where uncertain

Fault, dashed where uncertain.

Well

S
Spring

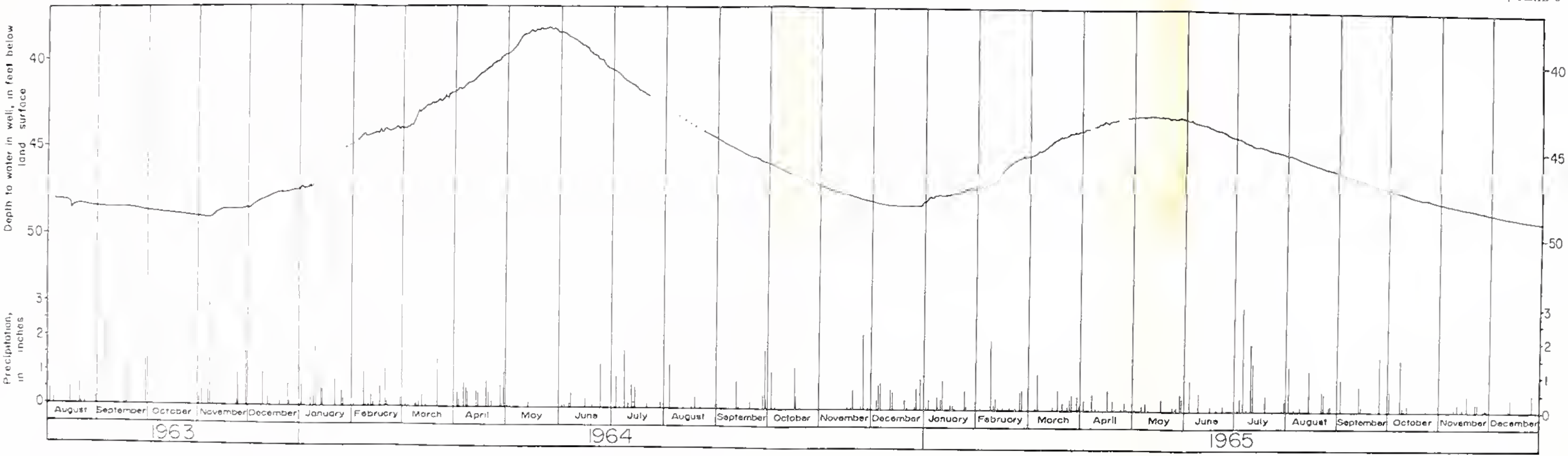


Plate 3. Graph Showing Water-Level Fluctuations in Well 956-555-1
and Precipitation at U.S. Weather Bureau Station at Coatesville